Project No. 249024

NETMAR

Open service network for marine environmental data

| **Instrument:** *Please tick* | CA | ✓ **STREP** | IP | NOE |
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**ICT - Information and Communication Technologies Theme**

# D7.5.1 Dissemination material and reports from workshops and standardisation activities

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Nansen Environmental and Remote Sensing Center

Revision 1

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| Draft | 2012-05-04 | Feedback from quality control incorporated. | M. Grant,<br>A. Patterson,<br>T. Hamre |
| 1 | 2012-05-04 | Final release approved. | T. Hamre |

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# Executive Summary

NETMAR aims to develop a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. It will be a user-configurable system offering flexible service discovery, access and chaining facilities using Open Geospatial Consortium (OGC), Open-source Project for a Network Data Access Protocol (OPeNDAP) and World Wide Web Consortium (W3C) standards. It will use a semantic framework coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data. EUMIS will also enable further processing of such data to generate composite products and statistics suitable for decision-making in diverse marine application domains.

EGU 2012 has been a targeted event for presenting NETMAR results to the wider scientific community. Three presentations and one poster were presented at this event, a general overview of the EUMIS platform, a presentations and demonstration of some of the web processing services developed in the project, a presentation of the use of SOA (Service Oriented Architecture) patterns and a poster on the NERC vocabulary server and its use in supporting so-called “smart” search. All together the three presentations and the poster were viewed by ~150 people, and thus NETMAR results presented to a wide range of scientists and developers within the field of environmental information systems and earth & space systems informatics (data scientists). Combined with discussions during breaks and poster sessions, the concepts and concrete results of the project were widely disseminated to relevant scientific and technical communities.

During EGU 2012, NETMAR also organised a public splinter meeting where two experts in oceanographic data management and uncertainty modelling were invited. They presented some of their work, together with some of the NETMAR partners who presented work done within the project, and the topics presented, among others, faceted search, representation of uncertainty and web processing services were discussed. Unfortunately, with the extensive programme of EGU 2012, there were many competing sessions and only one external scientist attended the NETMAR Public Splinter meeting. In particular, the session on Geoinformatics and Education (EOS6/ESSI2.3) and the splinter meeting on Marine Data Management (SPM2.46) are both assumed to have been attended by a large number of conference participants, some of which may otherwise have attended the NETMAR Splinter Meeting. Still the discussion and sharing of experiences with semantic resources (vocabularies and ontologies) and smart search, as well as representation and handling of uncertainty in workflows relaying on web processing services was valuable for participants.

At the 6th NETMAR Progress Meeting in February 2012, the following strategy was proposed for submission of specifications from the project to the GEOSS Best Practices Wiki:

- Phased approach
- Production ready components
- Used (but not demonstrated) by customers
- Detailed justification for ‘best practice’

At this meeting it was also decided that the submission to the GEOSS Best Practices Wiki should be done for each major component of the project: (1) Overall architecture, patterns, (2) Semantic framework, (3) Uncertainty handling in service chains (workflows), (4) Service chaining editor, (5) Workflow (engine), (6) GIS Viewer, (7) Vocabulary server and (8) Discovery client (including ontology browser). At the time of writing the specification of the semantic framework has just been submitted, while the best practice paper on architecture is in the process of being finalised for submission.

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# Contents



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# 1 Introduction

## *1.1 Background*

NETMAR aims to develop a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. It will be a user-configurable system offering flexible service discovery, access and chaining facilities using Open Geospatial Consortium (OGC), Open-source Project for a Network Data Access Protocol (OPeNDAP) and World Wide Web Consortium (W3C) standards. It will use a semantic framework coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data. EUMIS will also enable further processing of such data to generate composite products and statistics suitable for decision-making in diverse marine application domains. Figure 1-1 illustrates how observations, derived parameters and predictions are retrieved from a distributed service network through standard protocols, and delivered through the EUMIS portal using ontologies and semantic frameworks to select suitable products and where new products can be generated dynamically using chained processing services.

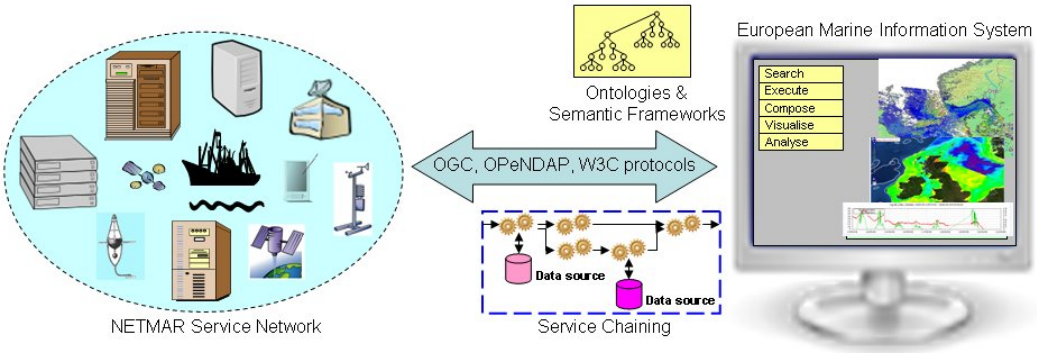


*Figure 1-1 The NETMAR system concept.*

Four pilots have been defined as testbeds for the developed EUMIS components and the underlying semantic resources:

- Pilot 1: Arctic Sea Ice and Met-ocean Observing System
- Pilot 2: Oil spill drift forecast and shoreline cleanup assessment services in France
- Pilot 3: Ocean colour – Marine Ecosystem, Research and Monitoring
- Pilot 4: International Coastal Atlas Network (ICAN) for coastal zone management

## *1.2 Objective of this report*

This reports presents the presentation and workshop carried out at EGU 2012, and the work done so far in the project w.r.t. submitting selected results from the project as best practice documents to the GEOSS Best Practice Wiki.

## *1.3 Terminology*

A **vocabulary** can be either a list of terms or a list of terms and some text providing a definition of the term. A vocabulary ensures that terms are used, and spelt, consistently. A vocabulary can be extended in its power by providing definitions of concepts.

A **thesauri** expand the knowledge contained within a vocabulary by adding information about the relationships between the terms of the vocabulary. These relationships fall broadly into three categories:

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- Synonyms – the current term is synonymous with a given, different term. E.g. “dogs” is synonymous with “canines”.
- Broader relations – the current term has a more specific definition than a given different term. E.g. “dogs” has a broader relationship to “pets”
- Narrower relations – the current term has a less specific definition than a given different term. E.g. “dogs” has a narrower relationship to “terriers”

In a more complex thesaurus, the concepts at the top of the hierarchy of broader and narrower relations may be stated explicitly, rather than being inferred by software agents. This provides the simplest form of a formal **ontology**.

A **portal** is a web site that collects input from a number of sources, and presents it in a uniform manner to the user. The portal content is perceived to come from the same source – the portal – while it typically is a combination of content from several sources, or an extract of selected content from a single external source (such as a news feed).

A **portlet** is portal component that can be deployed in a portal. A portlet can provide many types of functionality, among others, retrieve data from external sources, process and analyse data, present retrieved data on a geographic map. A portlet can also communicate with other portlets running in the same portal.

### *1.4 Organisation of this report*

The rest of this report is organised as follows. Section 2 summarises the presentations at workshop at EGU 2012. Section 3 presents the strategy for submitting selected results from the NETMAR project as best practices to the GEOSS Best Practice Wiki, while appendices contains the presentations (Appendix A) and best practice documents (Appendix B).

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# 2 NETMAR at EGU 2012

## *2.1 Objectives and targeted users*

The objective was to reach a wide scientific community working with environmental data and information systems and make them aware of selected aspects of NETMAR, and to engage a smaller focused group in discussion of key issues in NETMAR such as ontologies, semantic search and web processing services. The first objective was targeted by giving three presentations and one poster in the regular sessions of the ESSI (Earth & Space Science Informatics), and the second through a so-called Splinter Meeting, which is a topical meeting that can be freely proposed by the attendants of the EGU conference.

## *2.2 Presentations and demonstrations in regular sessions*

NETMAR was presented/demonstrated in three oral sessions and one demonstration session at EGU 2012, as well as in one poster. The submitted abstracts and the presentations are found in Appendix A.

### 2.2.1 *EUMIS - an open portal framework for interoperable marine environmental services*

Torill Hamre, NERSC, presented the EUMIS portal and components [HSL+12] in the session ESSI1.2/OS4.7 – Informatics in Oceanography and Ocean Science. The presentation covered the objectives and concepts of EUMIS, the four pilots and the three developed components (GIS Viewer, Discovery Client and Service Chaining Editor. Due to time restrictions, there were no questions to the presentation.

### 2.2.2 *Creating OGC Web Processing Service workflows using a web-based editor*

Jorge de Jesus, PML, presented some of the work done on web processing services and PyWPS done in NETMAR, as well as the service chaining editor [JGW12], in the session ESSI2.12 Real use of Standards and Technologies – Live Demonstrations. He demonstrated the service chaining editor and showed one of the workflows combing WPS services from NERSC and PML that have been published on www.myExperiment.org.

There was a question on the motivation for making a GUI for the service chaining editor; as the participant stated he would have preferred a scripting language to specify workflows. De Jesus replied that the editor is being developed for non-programmers, so a GUI was found to be the most suitable interface. Another participant asked if NETMAR planned to address checking of input parameters, to which de Jesus replied that semantic checking when linking services in a workflow will be addressed in the last year of the project.

### 2.2.3 *Using SOA Patterns to promote understanding across disciplines*

Anthony Patterson, UCC (CMRC), presented his paper Using SOA Patterns to promote understanding across disciplines [Pat12] in the session ESSI 2.7 Service Architecture challenges for multi-disciplinary systems. He gave some background on SOA comparing it with traditional OO way of thinking about systems and showing some examples of patterns (Front End, Service Host). He also introduced the pilots of NETMAR, to illustrate the multi-disciplinary aspects of the project.

The session chair asked if the use of patterns was helping in “bridging the gap between IT and domain” and of experiences of talking about patterns with users and domain experts.

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Patterson replied that patterns were in fact helpful in explaining IT concepts to users, such as the use of the Front End patterns to develop a uniform user interface. Patterns provide a problem statement, context information and a proposed solution, which can be useful when discussing with users and domain experts (in other fields than IT).

#### 2.2.4 *The NERC Vocabulary Server: Version 2.0*

Adam Leadbetter, NERC (BODC), presented a poster on the NERC vocabulary server [LRC12] in session ESSI2.5 Metadata, Data models, and Semantics, showing results of upgrading the NVS from version 1 to 2 and applications which have been built on top of the new version of the vocabulary server.

The questions addressed to the poster covered two areas. One was compatibility with other vocabulary servers, which we have achieved through both surveying the API methods of other servers and implementing the common methods, and through consulting with experts in the field, such as Simon Cox, on the content of the payload documents. The second question was around deployment of vocabularies on the server, which the cookbooks address, or deployment of the Vocabulary Server software on other domain names.

### *2.3 NETMAR Public Splinter Meeting*

The NETMAR Public Splinter Meeting was organised on Wednesday 25 April, 13:30-15:00.

#### 2.3.1 *Program*

The original program was as follows (slides in Appendix A):

1. NETMAR Overview Adam Leadbetter, NERC
2. User interaction and pilot studies Torill Hamre, NERSC
3. Building the system architecture Anthony Patterson, CMRC
4. What faceted search and ontologies have done for us Cyndy Chandler, BCO-DMO, Woods Hole
5. Building the NETMAR semantic resource Adam Leadbetter, NERC
6. Why worry about uncertainty Dan Cornford, Aston University
7. NETMAR services Jorge de Jesus, Plymouth Marine Lab.

Since several of the topics were covered in the regular sessions, we decided to focus on the practical aspects of “smart” search and processing services, leaving ample time for questions and discussions.

#### 2.3.2 *Summary of presentations and discussions*

Adam Leadbetter, NERC (BODC) gave a short introduction to the NETMAR project outlining the objectives of providing not only data discovery but also service discovery, data processing services as well as semantic search and semantic chaining of processing services. He then briefly presented the four pilots, point out that w.r.t. semantic resources the three first (sea ice, oil spills and ecosystem) shared underlying vocabularies with pilot specific terms as entry points, while the fourth pilot, ICAN, has its own vocabularies (for different themes such as coastal erosion).

Dr Cyndy Chandler, BCO-DMO (Biological and Chemical Oceanography Data Management Office), Woods Hole, gave a comprehensive presentations of work done at her institution to build up a joint system for serving biological and geochemical ocean data to the public. She presented some of the history of data collection within these fields, starting from initial simple

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data archiving systems to today's system offering flexible smart search and web-GIS display of data from all NSF funded scientists collecting biological and chemical oceanographic data.

For the "smart" search BCO-DMO used *faceted search*, which allows for flexible data exploration combining multiple search facets, such as platform, instrument, person (PI), etc. The search is very flexible in that the order of search facets can be defined by the user (each user individually) allowing him/her to explore what data sets are available in the most natural way for him/her. The faceted search is implemented using the S2S framework [RWW+12], which is developed by Peter Foxes' group at TWC-RPI (Tetherless World Constellation, Rensselaer Polytechnic Institute), US, as a set of widgets that are used to implement widgets for entering search criteria and displaying results (lists, maps with symbols).

BCO-DMO currently stores its metadata in MySQL, with additional mapping from BCO-DMO instrument types and platform types, to the standard SeaVox (SeaDataNet + MarineXML) vocabularies. Data for the facets are extracted and stored in a triple store for faster execution of queries. The triple store is updated daily with the new data sets ingested during the last 24 hours.

BCO-DMO has invested a significant amount of work in making all metadata available in a common format and mapping from the terms used by the BCO-DMO community to the terms used by SeaVox. This together with the S2S implementation has facilitated a very flexible "smart" search in the BCO-DMO portal (http://bco-dmo.org/).

Dr Chandler also showed two videos illustrating the use of the BCO-DMO portal. The first video demonstrated how a user could start the search from a person's name, perhaps after having read an article of the this person and wanting to look for the data he/she has used, and the select more search criteria such as (research) programme, project, etc. The most important search criteria (for the user) is moved to the top of the search area and as more widgets for search criteria are added and selections made in each, the list of found dataset is updated as well as symbols added on the map.

The second video illustrated how search for data from a particular instrument can be carried out, starting with a search facet for instrument category and then adding facets instrument, parameter category etc. for each facet added and desired values selected the list of datasets and map is updated dynamically.

The discussion covered the S2S framework, whether it was public (yes), if new facets could be easily added (yes, need to implement a widget for it and a class in the ontology), what programming language was used (JavaScript), and whether users found the faceted search easy to use (yes, most users understood how to use it after a 5-10 min demo). Regarding the construction of ontologies and use of standard vocabularies, Chandler emphasised the importance of keeping the terms used by the user community and map these to the standard terms. We also discussed how standardised metadata could be generated by the sensor themselves in the future by adding the standard vocabulary terms for instruments and parameter in the information package sent from the sensors to the data collection system.

Dr Leadbetter continued with a short presentation of the semantics and smart search needed in NETMAR, in the ICAN use case and jointly for the three first pilots. He demonstrated how this would look like in the EUMIS portal, using screenshots as the Internet connection in the meeting room was slow and unstable. The attendants were given the URL of the EUMIS portal, http://eumis.nersc.no/, so they can test for themselves after the meeting.

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Dr Dan Cornford, Aston University, UK, gave a short presentation of uncertainty. He emphasised the measures of uncertainty is subjective, even if we as scientists may like to think we can give this objectively. Different methods of specifying uncertainty are possible, e.g. probabilistic methods, providing samples of the data and statistics. UncertWeb is using probabilistic methods to specify uncertainty, and has several use cases (biodiversity, land-use change, air quality) to illustrate this. Aston University has also implemented an web-based tool, with HTML GUI, that allows a user to investigate and extract information about your data. The tool, called Elicitator (http://elicitator.uncertweb.org/), allows multiple users to specify their expectations and then products a probability distribution of whether the data meets these expectations. Pilot 3 in NETMAR will serve as another use case for UncertWeb, applying and adapting the UncertML (http://www.uncertml.org/) model for oceanographic observational and model data, and thus providing a different test environments than the use cases developed as part of the UncertWeb project.

Jorge de Jesus, Plymouth Marine Laboratory, UK, presented briefly some of his work on web processing services in NETMAR, including work on making PyWPS more standards compliant. He showed a demo WPS service calculating the shortest path from point A to B chosen on a map, as an example in OpenLayers, using GRASS-GIS's v.net.path. The GRASS-GIS Bridge, a set of General GIS services has been implemented as WPS services in NETMAR, meaning that approx. 150 WPS services are available at PML (http://rsg.pml.ac.uk/wps/index.html). Examples of workflows developed in the project were shown; some of these are publicly available on www.myExperiment.org. He also demonstrated the WPS “traffic light” examples at http://rsg.pml.ac.uk/rest/test.html that checks if two parameters are compatible or not. For this he pointed out the link to the standard vocabularies in the service metadata that are used to determine whether two parameters are compatible or not.

We discussed how semantics in service chaining with respect to ensuring proper input is provided to a WPS services by means of conversion services, e.g. converting from degrees Kelvin to degrees Celsius. Dr. Cornford also pointed out another general conversion WPS service, doing resolution conversion, implemented by University of Muenster in UncertWeb, could be another useful service for construction of workflows when output from one WPS service is not “compatible” with the expected input of the subsequent WPS service in the flow.

## *2.4 Other dissemination during the conference*

*NETMAR participation in EGU Workshop SPM2.9 (Marine Data Management Collaboration Meeting) on Thursday 26 April.*

Adam Leadbetter, BODC, was invited by Dr Helen Glaves, British Geological Survey, to attend a splinter meeting marine data management. At this meeting he presented some results of NETMAR on ontology and semantic resource development and access. The NVS V2 with its new and standardised API for access via web (REST and SOAP) was presented and discussed in the framework of marine data management.

Also in attendance were Stephen Miller (Head of the Geological Data Center at the Scripps Institution of Oceanography), Cycndy Chandler (Woods Hole Oceanographic Institute), Scott Bainbridge (Australian Institute of Marine Science) and Kerstin Lehnert (Lamont-Doherty Earth Observatory, Columbia University).

*NETMAR participation in EGU Workshop SPM 2.57 (Workshop: Architecture of Future Tsunami Warning Systems) on Wednesday 25 April.*

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Anthony Patterson was invited by Prof. Dr. Joachim Wächter, convener of the EGU session NH5.7/ESSI1.7 'Architecture of Future Tsunami Warning Systems' and Coordinator of the EU project TRIDEC (Collaborative, Complex and Critical Decision-Support in Evolving Crises), to a workshop with the purpose of broadening and strengthening the network of scientists, engineers and stakeholders working in the context of Tsunami Early Warning Systems.

The discussion centred on forming a collaboration with the aim of producing a special Issue of 'Natural Hazards and Earth System Science' with focus on the 'Architecture/ Implementation of Future Tsunami Warning Systems'.

More broadly, the TRIDEC architects discussed issues they are encountering with the use of semantics in composing OGC services. NETMAR's focus on simple semantics and the use of semantics in process chaining is likely to be of benefit in the architecture of the TRIDEC system of systems. Contact details have been exchanged, and NETMAR will plan to demonstrate its implementation and present its architecture to this project in the near future.

## *2.5 Overall dissemination effect*

The three presentations and one poster were viewed by ~150 people, and thus NETMAR results presented to a wide range of scientists and developers within the field of environmental information systems and earth & space systems informatics (data scientists). Combined with discussions during breaks and poster sessions, the concepts and concrete results of the project were widely disseminated to relevant scientific and technical communities.

The number of attendants at the Splinter Meeting was low, 2 invited external experts, Dr Cynthia Chandler, BCO-DMO, US and Dr Dan Cornford, Aston University, UK, and 1 external (potential) user. Still the discussion and sharing of experiences with semantic resources (vocabularies and ontologies) and smart search, as well as representation and handling of uncertainty in workflows relaying on web processing services was valuable for participants.

One possible reason for the low attendance at the NETMAR Public Splinter Meeting was the scale of the conference with many sessions and other splinter meetings scheduled at the same time, among others

- EOS6/ESSI2.3 Modern Geoinformatics and Education
- CR1.20 - Applied Geophysics in Cryosphere Sciences
- GDB1 -Open Science and the Future of Publishing
- SPM1.30- HEPEX (addressing flooding monitoring and forecasting)
- SPM2.45 - IERS (International Earth Rotation and Reference System) Working Group on co-locations
- SPM2.46 - Marine Data Management II
- SPM2.62 - Deep Sea Frontier (EC project addressing sustainable management of oceanic resources on a European scale)

Of these, the session on Geoinformatics and Education (EOS6/ESSI2.3) and the splinter meeting on Marine Data Management (SPM2.46) are both assumed to have been attended by a large number of conference participants, some of which may otherwise have attended the NETMAR Splinter Meeting.

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# 3 Contact with GEOSS Best Practices Wiki

## *3.1 Submission strategy*

At the 6th NETMAR Progress Meeting in February 2012, the following strategy was proposed for submission of specifications from the project to the GEOSS Best Practices Wiki:

- Phased approach
- Production ready components
- Used (but not demonstrated) by customers
- Detailed justification for 'best practice'

At this meeting it was also decided that the submission to the GEOSS Best Practices Wiki should be done for each major component of the project, as listed in Table 3-1. The most suitable Benefit Area in GEOSS was later identified and is also included in the table.

The most suitable Best Practices Wiki section (Subject Heading) was later identified and is also included in the table. All NETMAR components are "Cross-Cutting" and may be applied to any of the 8 GEOSS Societal Benefit Areas.

*Table 3-1 NETMAR components to be submitted to GEOSS and Benefit Area.*

| **NETMAR component** | **GEOSS Cross-cutting area** |
|---|---|
| Overall architecture, patterns | Architecture and Data |
| Semantic framework | Architecture and Data |
| Uncertainty handling in service chains (workflows) | Architecture and Data |
| Service chaining editor | Science and Technology |
| Workflow (engine) | Science and Technology |
| GIS Viewer | Science and Technology |
| Vocabulary server | Science and Technology |
| Discovery client (including ontology browser) | Science and Technology |

## *3.2 Submission schedule*

The major components that were scheduled for submission first were

- Overall architecture, realised through a set of patterns
- Semantic framework

Thus, it was decided to prepare this in a form suitable for submission to the GEOSS Best Practice Wiki, during the period March-May 2012. At the time of writing, the semantic framework specification has been submitted, while the architecture best practice is being developed and will be finalised for submission shortly.

## *3.3 Best practice for semantic framework*

The best practice for the NETMAR Semantic Framework was submitted to the GEOSS Practice Wiki on April 26, 2012. The specification is found in NETMAR deliverable D4.3.2 – NETMAR Semantic Framework Specification – Final version.

## *3.4 Best practice for architecture*

A best practice paper for architectures based on SOA patterns is in preparation, and the current version is included in Appendix B of this report.

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# 4 References

[HSL+12] Hamre, T., S. Sandven, A. Leadbetter, V. Gouriou, D. Dunne, M. Grant, M. Treguer and Ø. Torget, 2012. EUMIS - an open portal framework for interoperable marine environmental services. Geophysical Research Abstracts, Vol. 14, EGU2012-10503, 2012. EGU General Assembly 2012.

[JGW12] de Jesus, J., P. Walker, and M. Grant, 2012. Creating OGC Web Processing Service workflows using a web-based editor. Geophysical Research Abstracts, Vol. 14, EGU2012-5734, 2012. EGU General Assembly 2012.

[LRC12] Leadbetter, A., R. Lowry and O. Clements, 2012. The NERC Vocabulary Server: Version 2.0. Geophysical Research Abstracts, Vol. 14, EGU2012-2943, 2012. EGU General Assembly 2012.

[Pat12] Patterson, A., 2012. Using SOA Patterns to promote understanding across disciplines. Geophysical Research Abstracts, Vol. 14, EGU2012-5263, 2012. EGU General Assembly 2012.

[RWW+12] Rozell, E., H. Wang, P. West, S. Zednik, and P. Fox, 2012. Configurable User Interface Framework for Data Discovery in Cross-Disciplinary and Citizen Science. Geophysical Research Abstracts, Vol. 14, EGU2012-12859, 2012. EGU General Assembly 2012.

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# Appendices

## *Appendix A. EGU 2012 Abstracts and presentations*

The following abstracts are included in the subsequent pages:

- Hamre, T., S. Sandven, A. Leadbetter, V. Gouriou, D. Dunne, M. Grant, M. Treguer and Ø. Torget, 2012. EUMIS - an open portal framework for interoperable marine environmental services. Geophysical Research Abstracts, Vol. 14, EGU2012-10503, 2012. EGU General Assembly 2012.
- de Jesus, J., P. Walker, and M. Grant, 2012. Creating OGC Web Processing Service workflows using a web-based editor. Geophysical Research Abstracts, Vol. 14, EGU2012-5734, 2012. EGU General Assembly 2012.
- Leadbetter, A., R. Lowry and O. Clements, 2012. The NERC Vocabulary Server: Version 2.0. Geophysical Research Abstracts, Vol. 14, EGU2012-2943, 2012. EGU General Assembly 2012.
- Patterson, A., 2012. Using SOA Patterns to promote understanding across disciplines. Geophysical Research Abstracts, Vol. 14, EGU2012-5263, 2012. EGU General Assembly 2012.

The following NETMAR Splinter Meeting presentations are included in the subsequent pages:

- NETMAR Overview Adam Leadbetter, NERC
- User interaction and pilot studies, Torill Hamre, NERSC
- Building the system architecture, Anthony Patterson, CMRC
- What faceted search and ontologies have done for us, Cyndy Chandler, BCO-DMO, Woods Hole
- Building the NETMAR semantic resource, Adam Leadbetter, NERC
- NETMAR services Jorge de Jesus, Plymouth Marine Lab.

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## *Appendix B. Best practice proposal for architecture*

The InfoQ article Pattern-Based Architecture Review[1] describes a lightweight iterative process for reviewing software architectures based on documented patterns. The outcomes from this review process, along with documented results of using the patterns in practice, will form the basis for submission of the NETMAR architecture to the GEOSS Best Practice Wiki.

**1. Quality Attributes**
The requirements listed are from D1.1. We compare them with the General Scenarios described in Applicability of General Scenarios to the Architecture Tradeoff Analysis Method[2]. We map from the requirement to one of the Appendix B tables describing high level quality attributes. We then map onto one of the scenario responses described within the table.

Although there is room for interpretation in this mapping, it seems obvious that the majority of requirements relate to usability, with modifiability second. Security is important for three requirements, and there are no specific requirements related to performance or availability. Within usability, the primary concerns are using the system efficiently and adapting to user needs. The prevalent response for modifiability requirements is the ability to locate places in the architecture to be modified; this relates to NETMAR's strategy of using standard interfaces wired together using service orchestration.

| ID | Description | Quality Attribute | Response |
|---|---|---|---|
| **R1** | All data sources must provide usage metadata necessary to automatically combine different sources:<br>Projection used.<br>The units of measure used for each parameter using a term from a defined vocabulary.<br>Each parameter should be labeled with a term from a defined vocabulary. | Modifiability | Locates places in the architecture to be modified |
| **R2** | All data sources must provide data using standard interfaces. | Modifiability | Locates places in the architecture to be modified |
| **R3** | When a new relevant data source becomes available, it should be possible to include it in the service without any additional programming as long as it follows the required data protocols and usage metadata. | Modifiability | Locates places in the architecture to be modified |
| **R5** | Maps shall be served via WMS so that they are viewable in several different GIS viewers. | Modifiability | Locates places in the architecture to be modified |
| **R6** | Visualization of parameters shall be done so they give relevant information to a end user. E.g. use symbols that are familiar to the end user. | Usability | "feel comfortable" |
| **R7** | The EUMIS portal must support inputing a route that shall be displayed as a part of a generated map. | Usability | "use a system efficiently" |
| **R8** | The EUMIS portal must support selecting a specific area of interest. | Usability | "use a system efficiently" |
| **R9** | The EUMIS portal must support sharing defined service chains with other users of the portal. | Usability | "use a system efficiently" |
| **R10** | The EUMIS portal must support creating, saving and loading service chains. | Usability | "use a system efficiently" |
| **R11** | All data sources must provide data using standard interfaces so that the information from several sources can be combined. | Modifiability | Locates places in the architecture to be modified |

[1] http://www.infoq.com/articles/ieee-pattern-based-architecture-reviews

[2] http://www.sei.cmu.edu/library/abstracts/reports/01tr014.cfm

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| | | | |
|---|---|---|---|
| | - Allows to browse/search resources | | |
| **R12** | Extended tools for changing the content of the map module, e.g. to change the displayed variables, or adjust the time. | Usability | "adapt the system" |
| **R13** | Display different model results layers in order to compare them with each other<br>Display all relevant data (meteo-oceanic data …) | Usability | "use a system efficiently" |
| **R14** | Display synthetic model results layers<br>Access to synthetic maps and information | Usability | "use a system efficiently" |
| **R15** | When a new relevant data sources (pollution observation, model results, model comparison analysis ..) becomes available it should be possible to include it in the service and send an alert to end-user | Modifiability | Deploys modification |
| **R16** | The EUMIS portal must Allows to navigate within scenario and/or time steps | Usability | "use a system efficiently" |
| **R17** | The EUMIS portal must allow context-dependent actions such as publishing/un-publishing | Usability | "use a system efficiently" |
| **R18** | The EUMIS portal must give access to cleanup history of a designated site<br>The EUMIS portal must display all relevant data (shoreline pollution, shoreline sensitivity, …) | Usability | "use a system efficiently" |
| **R19** | Enables to view features displayed as charts (for shoreline and cleanup survey evolution and statistics)<br>Access to synthetic maps and information | Usability | "use a system efficiently" |
| **R20** | All processing services must provide usage metadata sufficient to allow data sources to be matched to processing inputs. | Modifiability | |
| **R21** | The EUMIS portal must support running predefined service chains. | Usability | "adapt the system" |
| **R22** | Statistical comparison and generic web processing services are available. | Usability | "adapt the system" |
| **R23** | Datasets and processing services should support uncertainty throughout the processing chain. | Usability | "adapt the system" |
| **R24** | The creation of new service chains using data services that provide the necessary metadata and data protocols, without complex programming, should be supported by the service chaining editor within the portal. | Modifiability | |
| **R25** | Data sources must provide at least discovery metadata. | Modifiability | Locates places in the architecture to be modified |
| **R26** | All discovery metadata should be formatted and delivered through open standards. | Modifiability | Locates places in the architecture to be modified |
| **R27** | All accessible data sources must use open standards and open data transport formats. Any restricted data sources must describe means of obtaining data within the metadata (e.g. link to registration page, email address, etc.). | Modifiability | Locates places in the architecture to be modified |
| **R28** | EUMIS system needs to facilitate regional base metadata profile standards (e.g. INSPIRE in Europe, FGDC in U.S., etc.). | Modifiability | Locates places in the architecture to be modified |
| **R29** | Support for metadata visualisation. | Usability | "use a system efficiently" |
| **R30** | Support for smart search functionality, i.e. ability to search a keyword based on semantics. | Usability | "use a system efficiently" |
| **R31** | Support for multi-lingual and multi-domain ontologies. | Usability | "adapt the system" |
| **R32** | Support for ontology browsing. | Usability | "use a system |

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| | | | |
|---|---|---|---|
| | | | efficiently” |
| **R33** | The EUMIS portal must support common GIS operations like zoom, pan, restore original map extent, toggle layer display on/off, and simple colour manipulation. | Usability | “use a system efficiently” |
| **R35** | Support display of legends in web-GIS. | Usability | “use a system efficiently” |
| **R36** | User interactions should be as intuitive as possible, and allow the user to explore the available datasets as effortlessly as possible. | Usability | “use a system efficiently” |
| **R37** | Any user must be able to search the wiki and forum for information about products and services offered by EUMIS. The search criteria can be free text. | Usability | “learn system features” |
| **R38** | Any user must be able to navigate all pages of the wiki, and quickly get back to previous pages by using the “breadcrumb trail” at the top of the screen or the browser’s back button. | Usability | “learn system features” |
| **R39** | Any user must be able to view all categories, threads and posts of the forum. | Usability | “learn system features” |
| **R40** | A user must be registered to be allowed to post questions in the forum. | Usability | “learn system features” |
| **R41** | A user must be able to register with name, e-mail, password and optionally, organisation, position, professional/research interests in the EUMIS portal. | Usability | “learn system features” |
| **R42** | A service provider must be able to register with name, e-mail, password and optionally, organisation, position, professional/research interests in the EUMIS portal. | Usability | “learn system features” |
| **R43** | A service provider must be able to enter content into the wiki pages to describe his products and/or services. | Usability | “learn system features” |
| **R44** | The administrator must be able to assign permissions for editing wiki/posting in forum to a new provider/user, and place him in one of the defined communities. | Security | Allows access to data and/or services. |
| **R45** | The administrator must be able to reject a user that provides an invalid e-mail address. | Security | Grants or withdraws permission to access data and/or services |
| **R46** | The EUMIS portal must allow a registered user to run a pre-defined service chain or access a restricted product, provided that he belongs to the correct community. | Security | Allows access to data and/or services. |
| **R47** | The EUMIS portal must support display of multiple parameters in a common map projection, even if they have different spatial resolution and/or map projection. | Usability | “use a system efficiently” |
| **R48** | The EUMIS portal must support “smart search” by parameter name, allowing also datasets with related parameters to be found. | Usability | “use a system efficiently” |
| **R49** | The EUMIS portal must support queries by parameter name (“smart search”) combined with geographic area and/or time range. | Usability | “use a system efficiently” |

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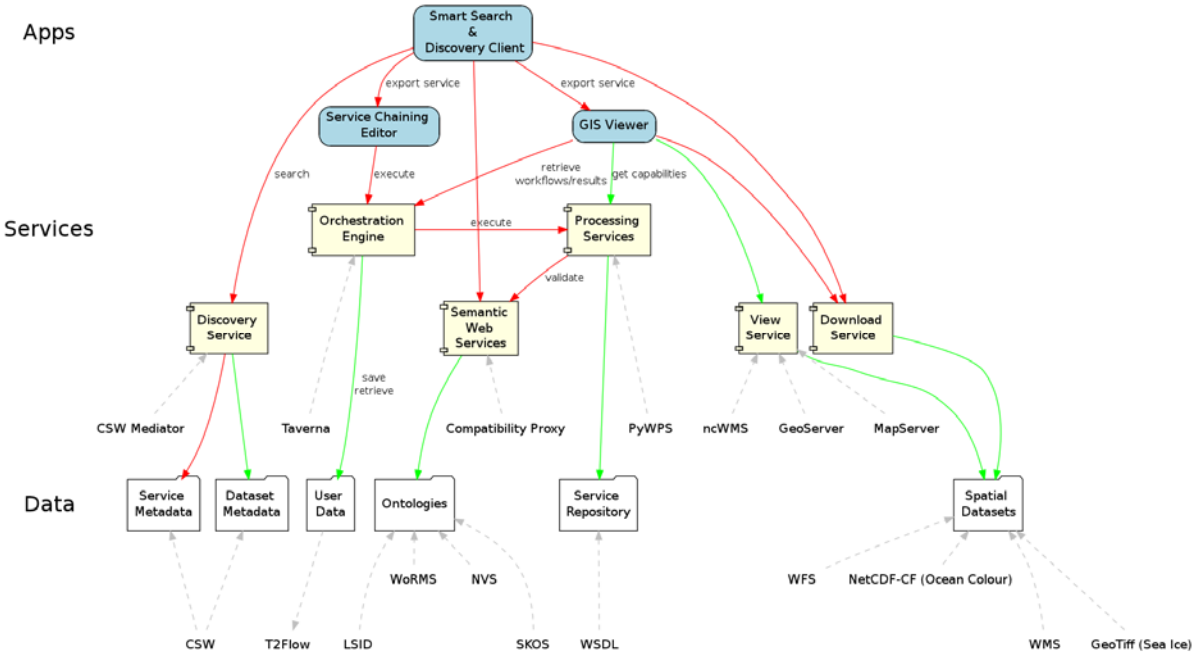
## 2. System Architecture




## 3. Pattern Summary

### 3.1 Composite Front End

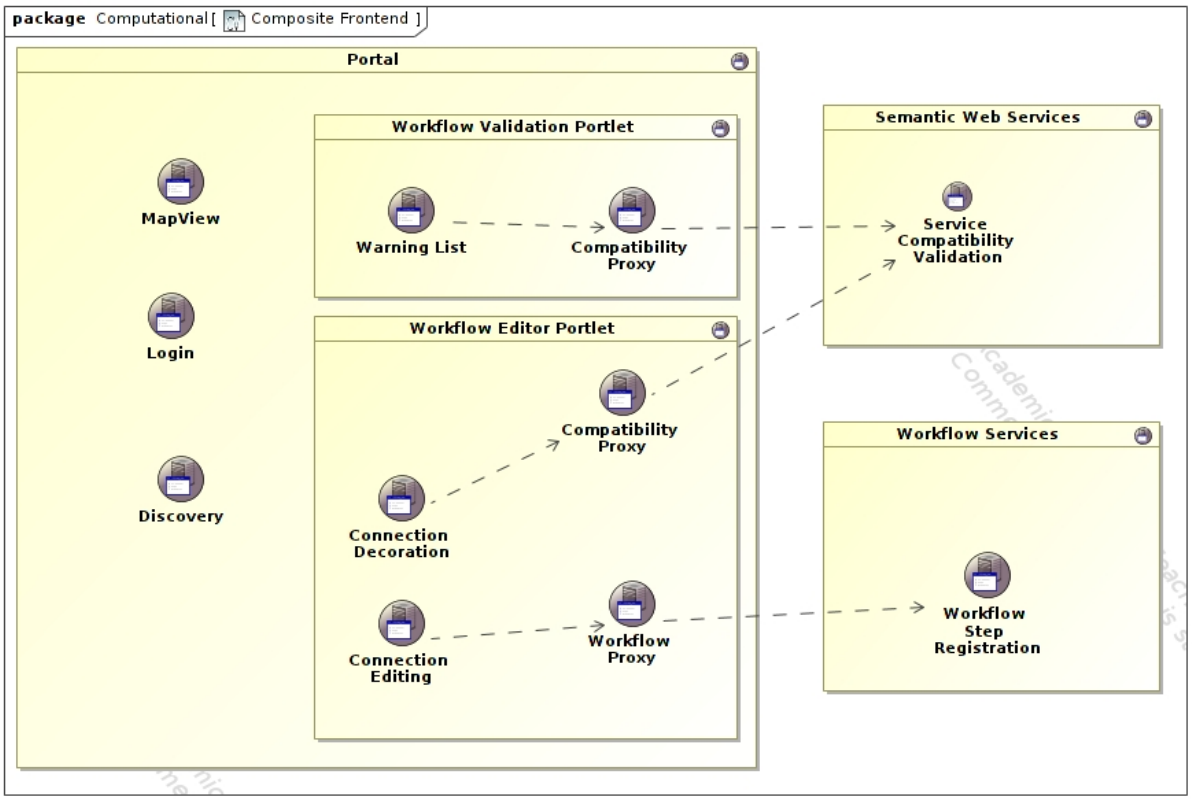



*Figure 0-1 Composite Front End pattern as applied to service compatibility validation*

The Composite Front End pattern aims to present a cohesive user interface to a number of separate services. It allows services to be designed with the SOA principles of modularity & reuse in mind, while hiding the decoupled nature of the services from the end user, who wishes to see these services combined in a way that meets a need.

In this case, the user is attempting to create a workflow involving a number of separate data and processing services. The user wishes to know if attempting to connect the output of a service to the input of another service makes good semantic sense, e.g. the units are dimensionally compatible.

The Portal provides unified client-side services such as layout and theming and a set of standard core services such as Discovery, MapView and Login. A Workflow Editor Portlet implements the specific composition of services that allows complex workflows to be created and shared.

The UI logic implemented by the Workflow Portlet includes the ability to edit a connection, i.e. attempt to create, delete or modify the pairing of a service output with an input from another service in order to create a link in a service chain. It provides for two possible feedback mechanisms related to service compatibility; a simple ex post facto list of warnings where services are not compatible, or a more dynamic feedback mechanism of decorating the link between output with e.g. a colour to indicate various degrees of compatibility violation. The ex post facto feedback is provided by a separate Workflow Validation Portlet which displays a simple list of warnings related to possible compatibility violations, while the dynamic feedback is provided within the Workflow Editor Portlet itself.

The UI components must in turn connect to service proxies in order to fulfil their tasks. There is one proxy per service which provides the model for the UI logic. The Compatibility Proxy connects to the Service Compatibility Validation service of the Semantic Web Services, and the Workflow Proxy connects to the Workflow Step Registration service of the Workflow Services.

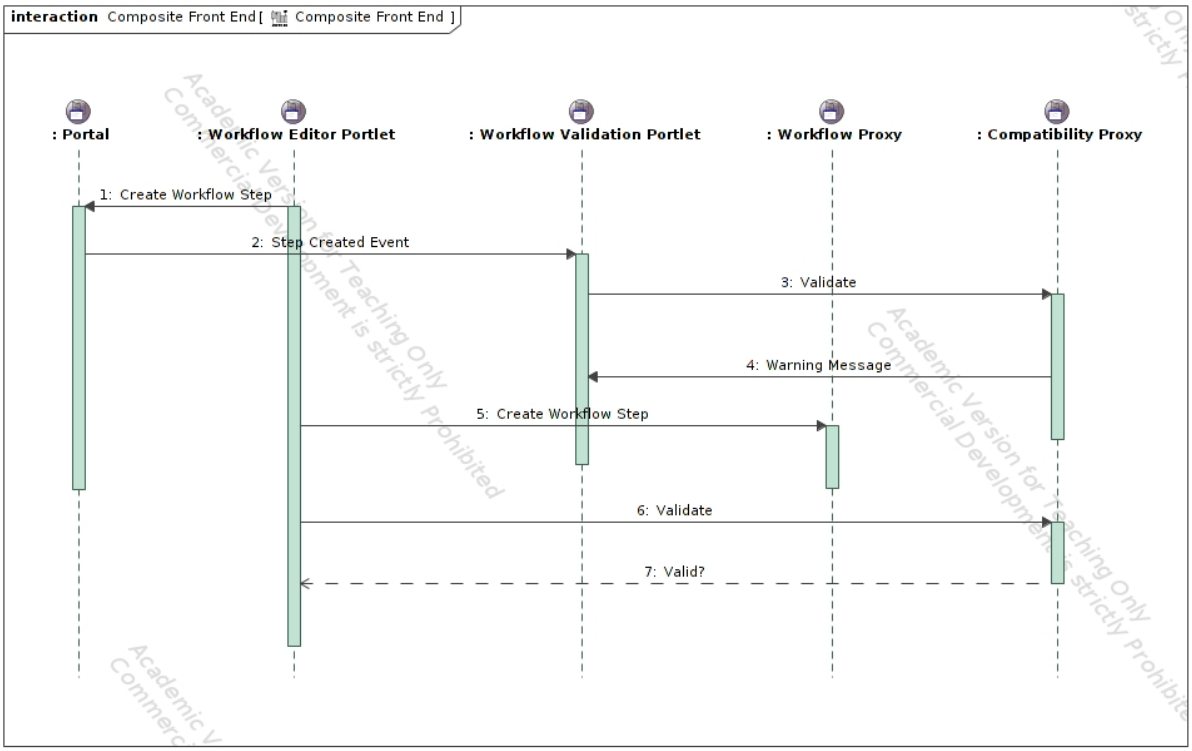



*Figure 0-2 Composite Front End pattern interactions*

The Sequence diagram in Figure 0-2 shows two patterns of interaction between host (Portal) UI code (Portlets) and Proxies. In the ex post facto validation scenario, the Workflow Editor Portlet notifies the Portal of the creation of a workflow step. The Portal in turn notifies the Workflow Validation Portlet which requests validation from its Compatibility Proxy. An asynchronous reply is generated by the

Compatibility Proxy containing a description of possible compatibility violations, which is then displayed within the Workflow Validation Portlet.

In the dynamic validation scenario, the Workflow Editor Portlet notifies directly its Compatibility Proxy and waits for a response. The response results in direct UI feedback, e.g. display of an icon or decoration on the connection element, or colour coding of the port.

NETMAR uses the Liferay Portal to implement the Composite Front End pattern.

The NETMAR Portal approach promotes the Quality Attributes of Usability and Flexibility. Usability is achieved through reoffering common UI services such as theming and login through a common interface. Flexibility is achieved by allowing the NETMAR core services to be combined in a variety of different ways while maintain both modularity of services and coherence at the application level.

A pattern which also works well with this scenario to address some possible performance and usability concerns is Inversion of Communication [RBD11]. In the dynamic editing scenario, the need to call out to an external service while editing may cause the UI to seem slow or unresponsive, depending on network latency, etc. One reason for using the ex post facto validation is that it can be used in a more event driven fashion to remove some of the runtime coupling that could cause performance issues.

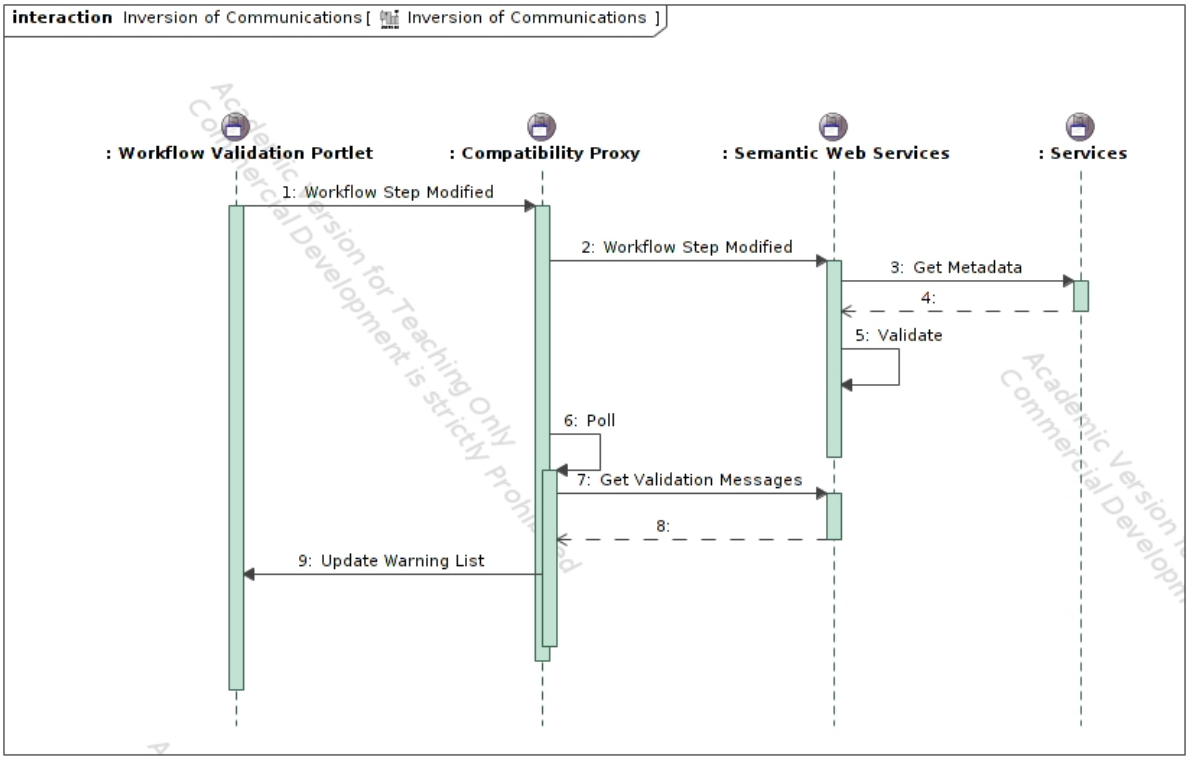



*Figure 0-3 Inversion of Communications*

Figure 0-3 shows how the backend communications with the Services might work using this pattern. In this case, the Compatibility Proxy pushes notifications of workflow change to the Semantic Web Services. The Semantic Web Services perform all necessary steps to obtain relevant metadata form the services involved in the workflow and validate compatibility, which may involve a considerable delay. As the validation is done, the results of the validation are stored by the Semantic Web services in a queue. The Compatibility Proxy can poll periodically for new validation messages and push them to the Workflow Validation Portlet as they arrive.

This removes some more design and runtime coupling between the Portal and the Semantic Web Services and reduces a possible source of delay on the UI side. There may be a loss in usability, as the feedback from compatibility errors becomes less immediate. If the queue is represented as an RSS

or Atom feed, then there is a very simple and direct technology mapping, as the Liferay portal has the ability to publish arbitrary feeds through a built-in widget.

**4. Analysis**
*Examine the architecture and qual-ity attributes together to determine each pattern's effects on the sys-tem's quality attributes. Review past scenarios, implementations, and where in the architecture the implementation occurs. Use existing pattern documentation to look for matches (and mismatches) between the patterns and quality attributes.*

**5. Outcome**
*Identify and discuss quality attribute issues, including quality attributes not addressed or adequately satisfied, patterns not used that might be useful, or potential con-flicts between patterns used and quality attributes. For example, a layered architecture is often incom-patible with a high-performance requirement.*

**6. References**
[RBD11] Rotem-Gal-Oz, Bruno, Dahan. SOA Patterns. Manning 2011.

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# EUMIS - an open portal framework for interoperable marine environmental services

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NETMAR (Open service network for marine environmental data) is an FP7 project that aims to develop a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. EUMIS will use a semantic framework coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data.

Four pilots have been defined to clarify the needs for satellite, in situ and model based products and services in selected user communities. The pilots are:
· Pilot 1: Arctic Sea Ice Monitoring and Forecasting
· Pilot 2: Oil spill drift forecast and shoreline cleanup assessment services in France
· Pilot 3: Ocean colour - Marine Ecosystem, Research and Monitoring
· Pilot 4: International Coastal Atlas Network (ICAN) for coastal zone management

NETMAR is developing a set of data delivery services for the targeted user communities by means of standard web-GIS and OPeNDAP protocols. Processing services and adaptive service chaining services will also be developed, to enable users to generate new products suited to their needs. Both data retrieved from online repositories as well as the products generated dynamically can be accessed and visualised in the EUMIS portal. For this purpose, a GIS Viewer, a Service Chaining Editor and a Ontology Browser/Discovery Client have been developed and integrated in EUMIS.

The EUMIS portal is developed using a portal framework that is compliant with the JSR-168 (Java Portlet Specification 1.0) and JSR-286 (Java Portlet Specification, 2.0) standards. These standards defines the interface (contract) and lifecycle management for a portal system component, a portlet, which can be implemented in a number of programming languages, not only Java. The GIS Viewer is developed using a combination of Java, JavaScript and JSF (e.g. MapFaces). The Service chaining editor is implemented in JavaScript (using different libraries like jQuery and WireIt), and the Ontology Browser/Discovery Client by means of Adobe Flex. In addition to the portlets developed in the project, we have also used several of the pre-built portlets that come with the Liferay Community Edition portal framework, notably the wiki, forum and RSS feed portlets.

The presentation will focus on the developed system components and show some examples of products and services from the defined pilots.

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# Creating OGC Web Processing Service workflows using a web-based editor

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The OGC WPS (Web Processing Service) specifies how geospatial algorithms may be accessed in an SOA (Service Oriented Architecture). Service providers can encode both simple and sophisticated algorithms as WPS processes and publish them as web services. These services are not only useful individually but may be built into complex processing chains (workflows) that can solve complex data analysis and/or scientific problems.

The NETMAR project has extended the Web Processing Service (WPS) framework to provide transparent integration between it and the commonly used WSDL (Web Service Description Language) that describes the web services and its default SOAP (Simple Object Access Protocol) binding. The extensions allow WPS services to be orchestrated using commonly used tools (in this case Taverna Workbench, but BPEL based systems would also be an option).

We have also developed a WebGUI service editor, based on HTML5 and the WireIt! Javascript API, that allows users to create these workflows using only a web browser. The editor is coded entirely in Javascript and performs all XSLT transformations needed to produce a Taverna compatible (T2FLOW) workflow description which can be exported and run on a local Taverna Workbench or uploaded to a web-based orchestration server and run there.

Here we present the NETMAR WebGUI service chain editor and discuss the problems associated with the development of a WebGUI for scientific workflow editing; content transformation into the Taverna orchestration language (T2FLOW/SCUFL); final orchestration in the Taverna engine and how to deal with the large volumes of data being transferred between different WPS services (possibly running on different servers) during workflow orchestration.

We will also demonstrate using the WebGUI for creating a simple workflow making use of published web processing services, showing how simple services may be chained together to produce outputs that would previously have required a GIS (Geographic Information System) locally.

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# Using SOA Patterns to promote understanding across disciplines

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The NETMAR consortium is building an open service network for marine environmental data by combining expertise from Ireland, France, the UK and Norway in disciplines such as Semantics, Software Engineering, UI Programming and Service Orchestration. Through the International Coastal Atlas Network, it engages user groups from Europe, Africa, Asia and the Americas. In doing so, it faces challenges in bringing these disciplines and groups together in a way that makes them greater than the sum of their parts.

Service Oriented Architecture has been successfully applied in many cases to help build useful systems across organisational and geographic boundaries in order to expose diverse capabilities which can function together through a mutual exchange of value. This should make it ideally suited to a distributed decision making environment without centralised command and control. In theory, SOA should facilitate the building of global and complex infrastructures and the integration of information systems characterized by diverse protocols and interfaces,and with different data policies and security levels.

The presentation will discuss a number of approaches used by NETMAR to bring the theory of SOA to bear in a useful way while maintaining the emphasis on keeping multi-disciplinary domain expertise as the primary driver of the project. It will discuss three approaches used:
. Populating one or more standard reference models
. Trade-off analysis based on business drivers and quality attributes
. Documenting design reuse in the form of patterns.

The three approaches will be compared in terms of how they succeed in bringing 'just enough' service architecture knowledge into the project. We discuss how the approaches can interact and complement each other. Finally, we present a number of SOA patterns identified as being relevant to NETMAR and explain why they are felt to be particularly effective in gaining consensus on how to build the NETMAR system of systems.

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# The NERC Vocabulary Server: Version 2.0

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The NERC Vocabulary Server (NVS) has been used to publish controlled vocabularies of terms relevant to the marine environmental sciences domain since 2006 (version 0) with version 1 being introduced in 2007. It has been used for

• metadata mark-up with verifiable content
• populating dynamic drop down lists
• semantic cross-walk between metadata schemata
• so-called smart search
• and the semantic enablement of Open Geospatial Consortium Web Processing Services

in projects including: the NERC Data Grid; SeaDataNet; Geo-Seas; and the European Marine Observation and Data Network (EMODnet).

The NVS is based on the Simple Knowledge Organization System (SKOS) model and following a version change for SKOS in 2009 there was a desire to upgrade the NVS to incorporate the changes in this standard. SKOS is based on the "concept", which it defines as a "unit of thought", that is an idea or notion such as "oil spill". The latest version of SKOS introduces the ability to aggregate concepts in both collections and schemes. The design of version 2 of the NVS uses both types of aggregation: schemes for the discovery of content through hierarchical thesauri and collections for the publication and addressing of content.

Other desired changes from version 1 of the NVS included:

• the removal of the potential for multiple Uniform Resource Names for the same concept to ensure consistent identification of concepts
• the addition of content and technical governance information in the payload documents to provide an audit trail to users of NVS content
• the removal of XML snippets from concept definitions in order to correctly validate XML serializations of the SKOS
• the addition of the ability to map into external knowledge organization systems in order to extend the knowledge base
• a more truly RESTful approach URL access to the NVS to make the development of applications on top of the NVS easier
• and support for multiple human languages to increase the user base of the NVS

Version 2 of the NVS underpins the semantic layer for the Open Service Network for Marine Environmental Data (NETMAR) project, funded by the European Commission under the Seventh Framework Programme.

Here we present the results of upgrading the NVS from version 1 to 2 and show applications which have been built on top of the NVS using its Application Programming Interface, including a demonstration version of a SPARQL interface.

# **EUMIS** - an open portal framework for interoperable marine environmental services

T. Hamre[1], S. Sandven[1], A. Leadbetter[2], V. Gouriou[3], D. Dunne[4], M. Grant[5], M. Treguer[6], and Ø. Torget[7]

[1]NERSC, [2]BODC, [3]CEDRE, [4]CMRC, [5]PML, [6]Ifremer, [7]METNO

*EGU 2012 – Vienna – 24 April 2012*

# Outline

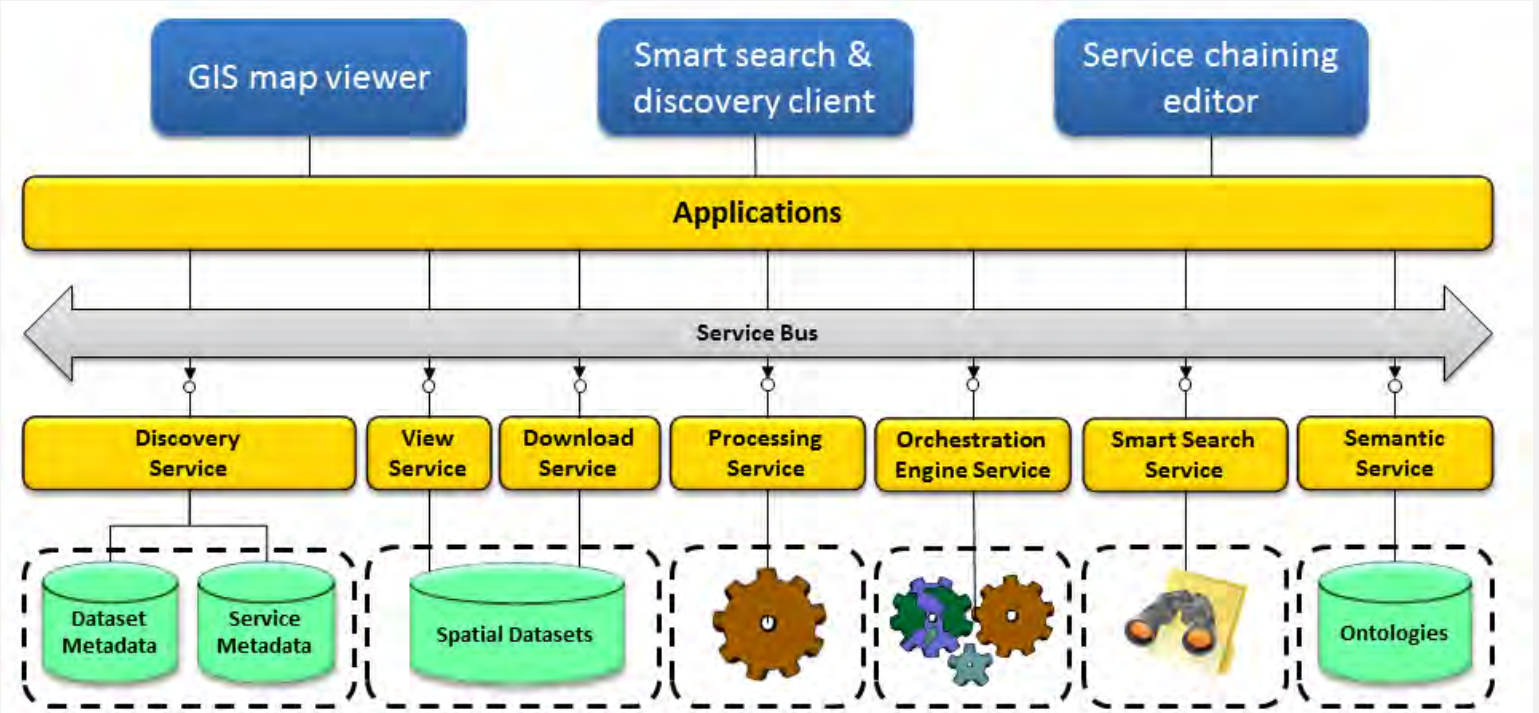
- Objectives and concepts
- Pilots
- Ontologies and semantic framework
- EUMIS portal and components
  - GIS Viewer
  - Discovery Client
  - Service Chaining Editor
- Conclusion

# Objectives and concepts

- NETMAR aims to develop a ***pilot European Marine Information System (EUMIS)*** for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. It will be a user-configurable system offering ***flexible service discovery, access and chaining facilities*** using OGC, OPeNDAP and W3C standards. It will use a ***semantic framework coupled with ontologies*** for identifying and accessing distributed data, such as near-real time, forecast and historical data. EUMIS will also enable further processing of such data to generate ***composite products and statistics*** suitable for decision-making in different marine application domains.

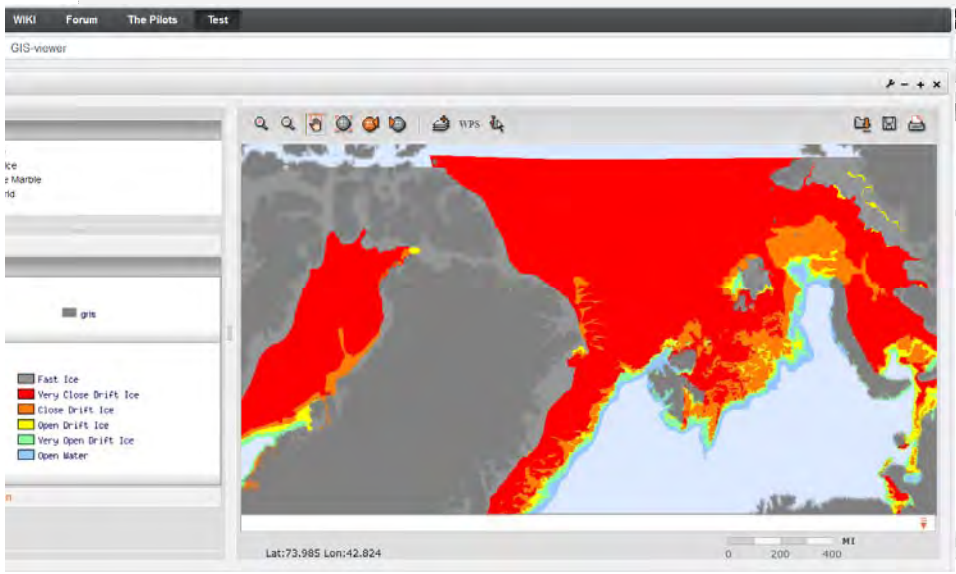
# Objectives and concepts

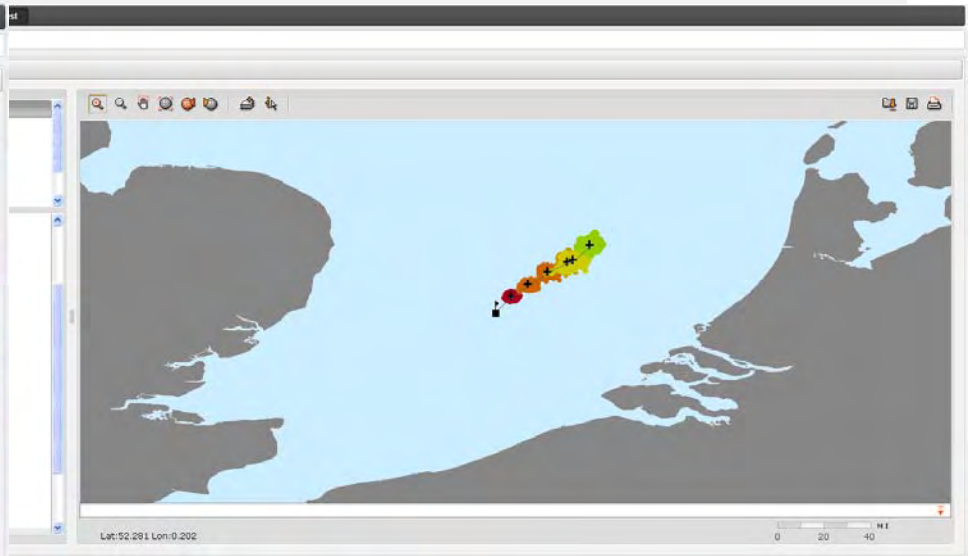
- NETMAR Service Oriented Architecture
  - Portal and components by JSR-168 JSR-286
  - Services by OGC, W3C and OASIS standards



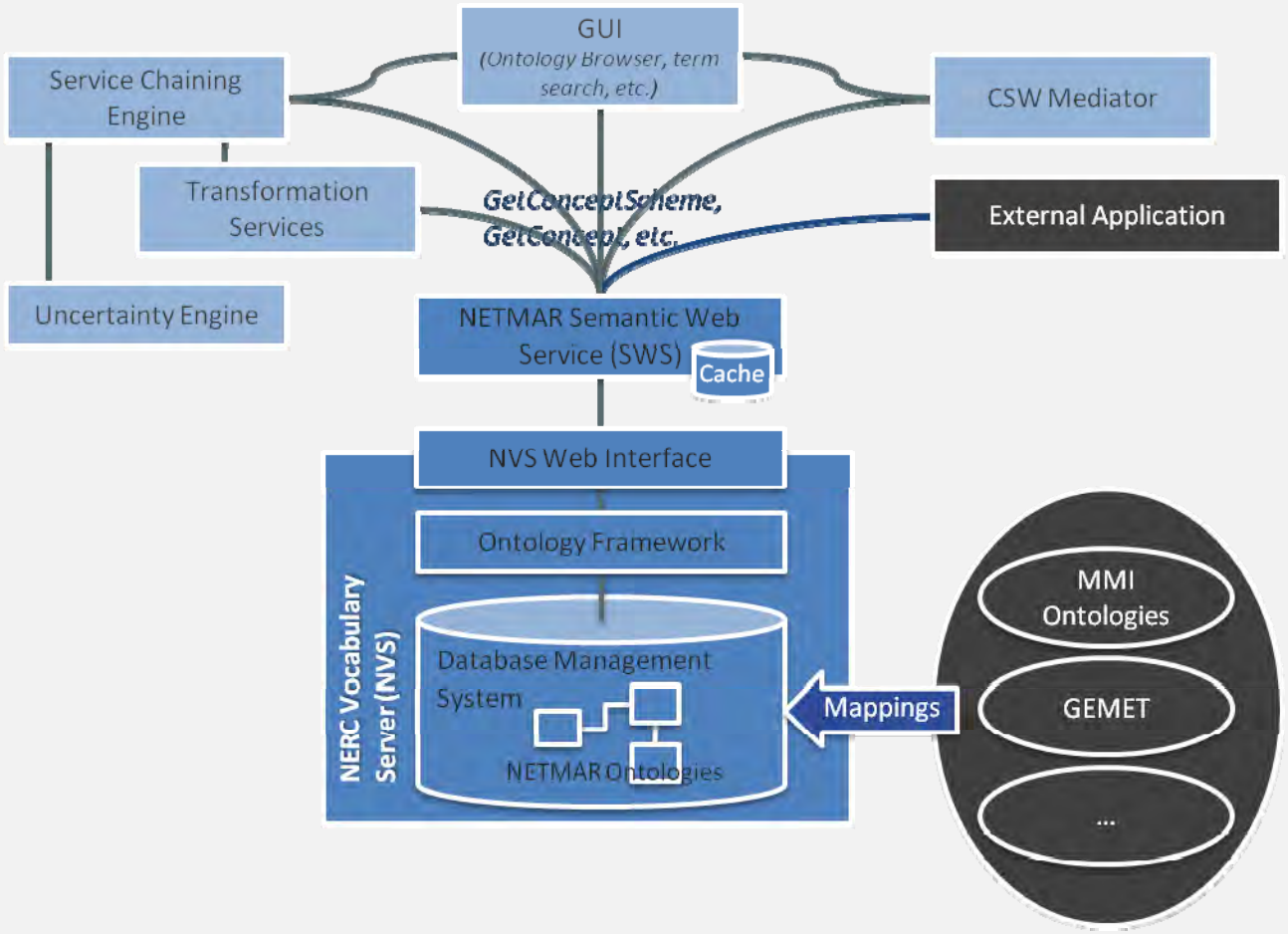
# Pilots

- Pilots in NETMAR
  1. Arctic Sea Ice monitoring and forecasting
  2. Oil spill forecasting and shoreline cleanup
  3. Ecosystem monitoring and modelling
  4. ICAN (International Coastal Atlas Network)



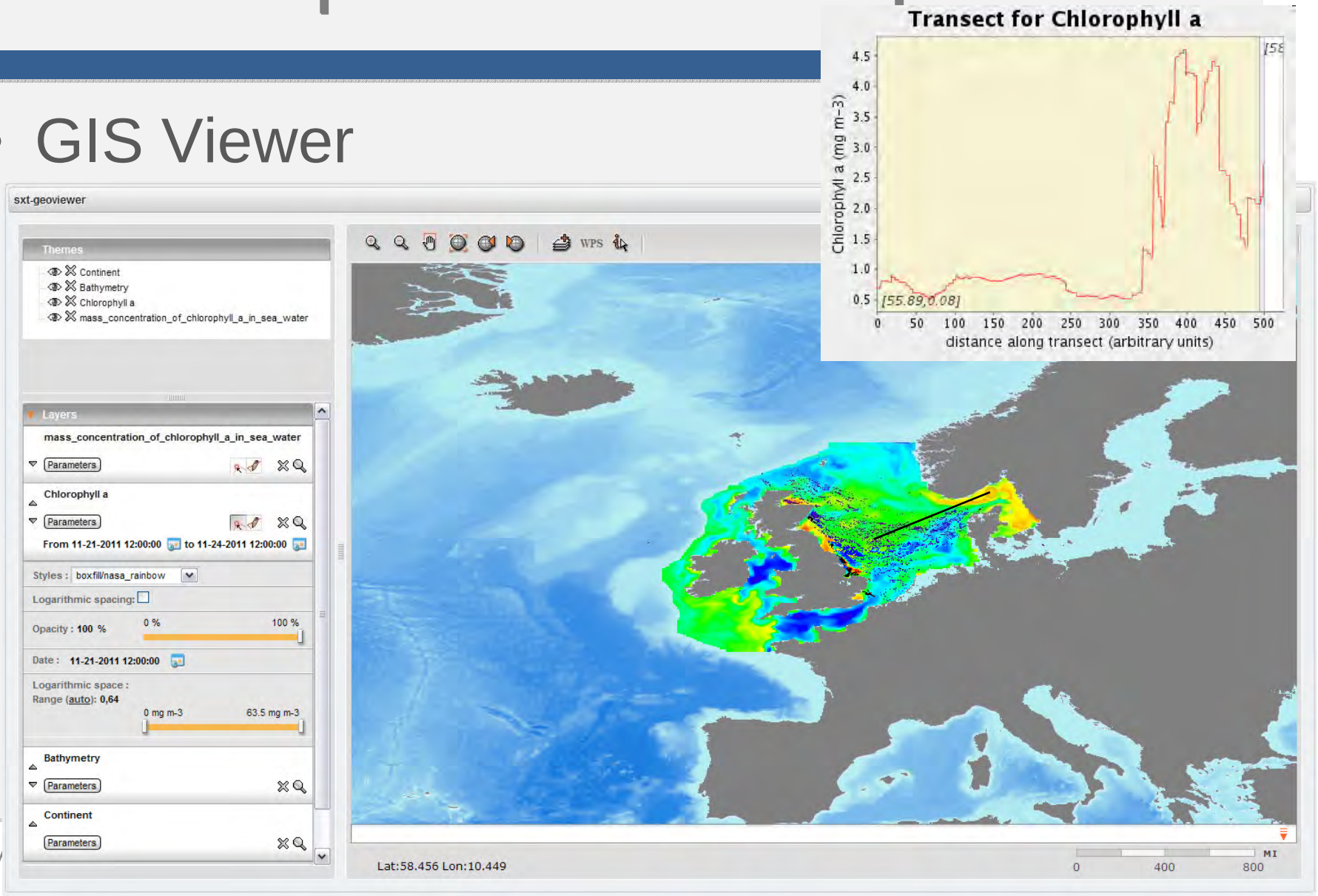



# Ontologies and semantic framework



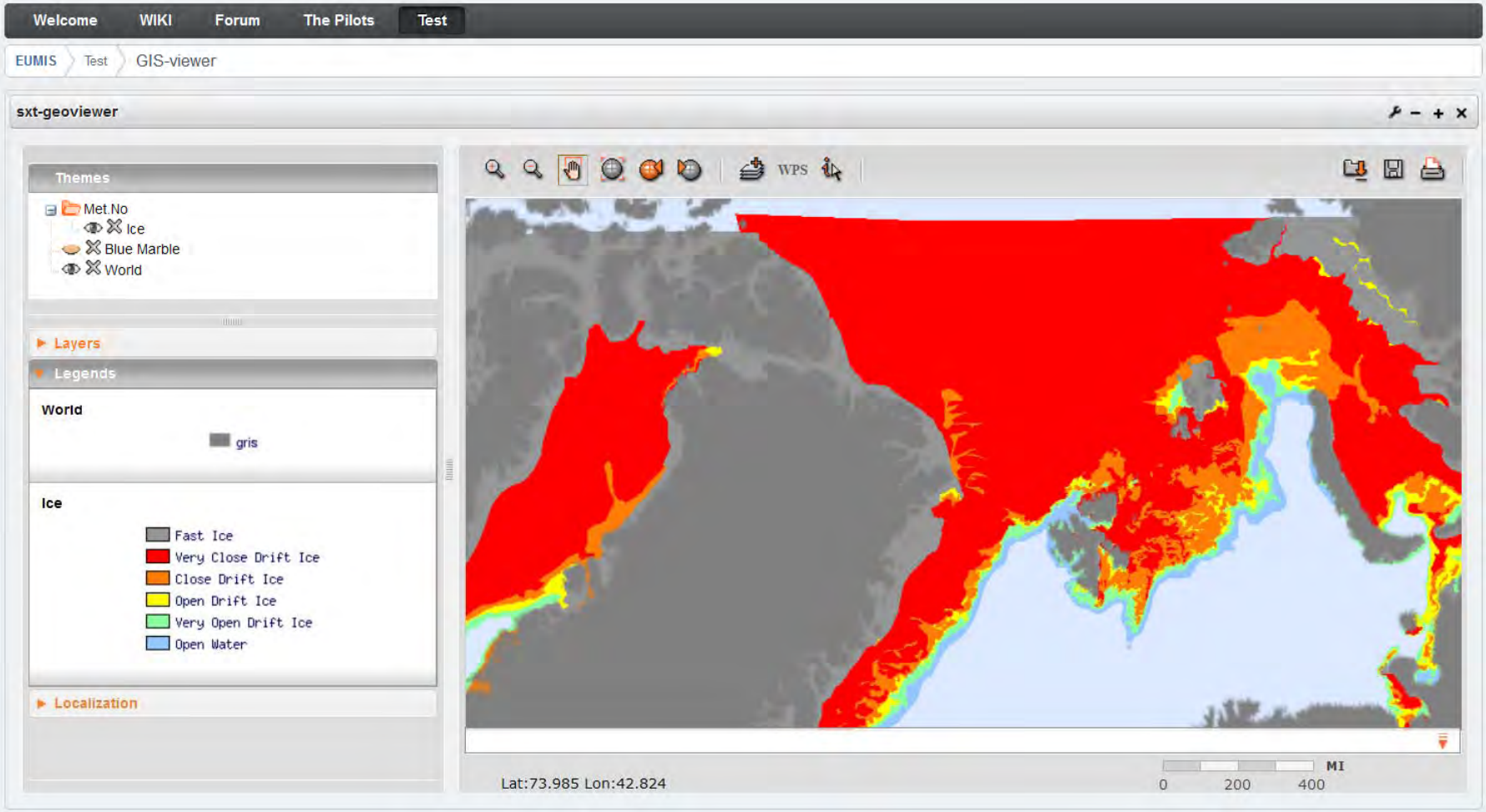
# EUMIS portal and components

- GIS Viewer



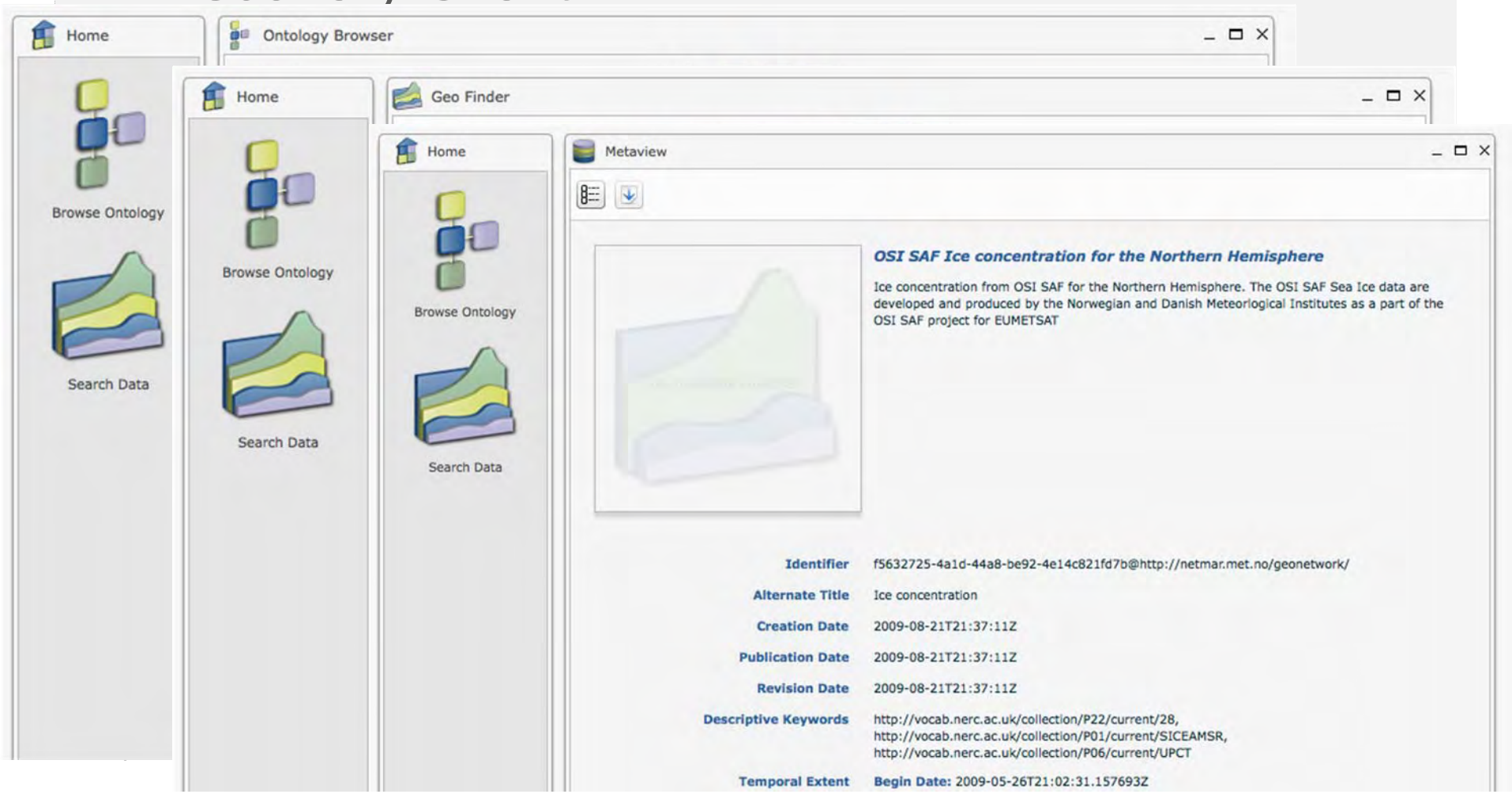
# EUMIS portal and components

- GIS Viewer



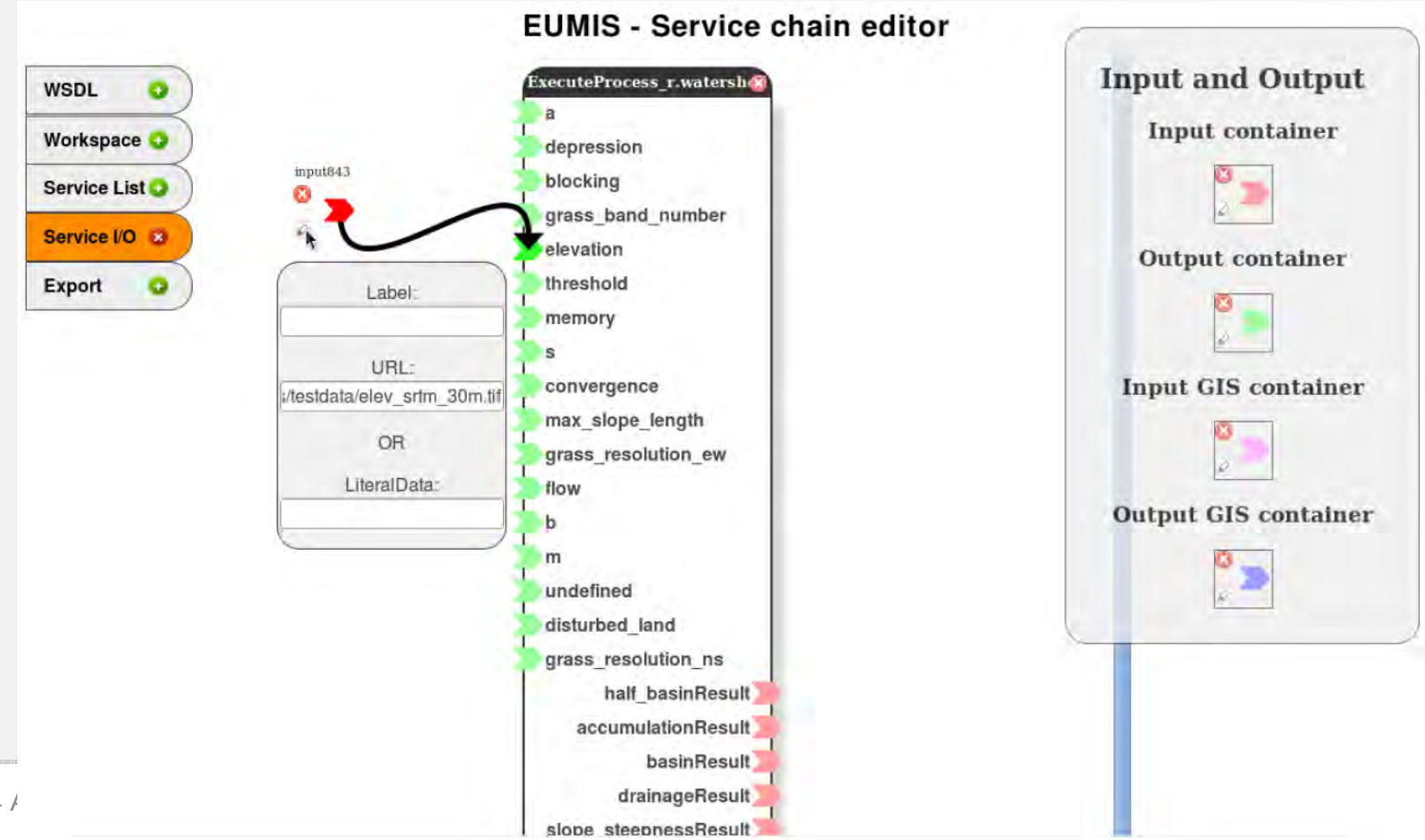
# EUMIS portal and components

- Discovery Client



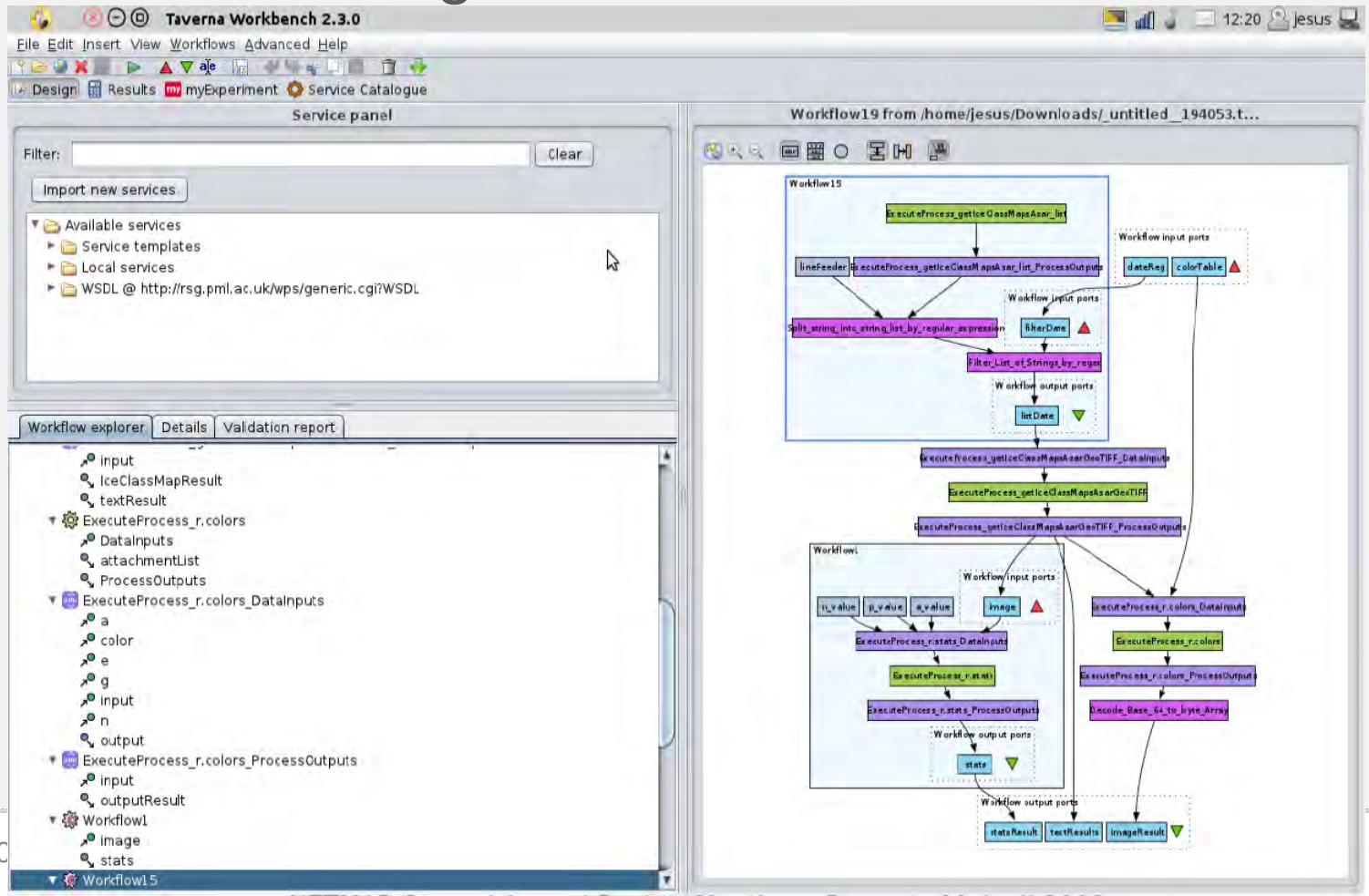
# EUMIS portal and components

- Service Chaining Editor



# EUMIS portal and components

- Service Chaining Editor



# Conclusion

- We have implemented a SOA for the EUMIS portal with a set of components
  - GIS Viewer - Discovery Client
  - Service Chaining Editor - Wiki, Forum, RSS feeds

  using multiple programming languages, and deployed them within the Liferay platform.
- The first version of EUMIS was tested for the four pilots in different marine application domains. User feedback was used to improve services and components.
- Positive experience with the Java Portlet Specification standard and the portal framework. With further work EUMIS can be developed into a sustainable system.

# More information

- NETMAR Public Splinter Meeting
  - Wednesday 25 April, 13:30-15:00, Room SM5
  - Presentations + Demonstrations
- NETMAR web site: http://netmar.nersc.no
- Contact Torill Hamre (torill.hamre@nersc.no)

# Thank you!

*T. Hamre[1], S. Sandven[1], A. Leadbetter[2], V. Gouriou[3], D. Dunne[4], M. Grant[5], M. Treguer[6], and Ø. Torget[7]*

*[1]NERSC, [2]BODC, [3]CEDRE, [4]CMRC, [5]PML, [6]Ifremer, [7]METNO*

Contact: Torill.Hamre@nersc.no

# Using SOA Patterns to promote understanding across disciplines

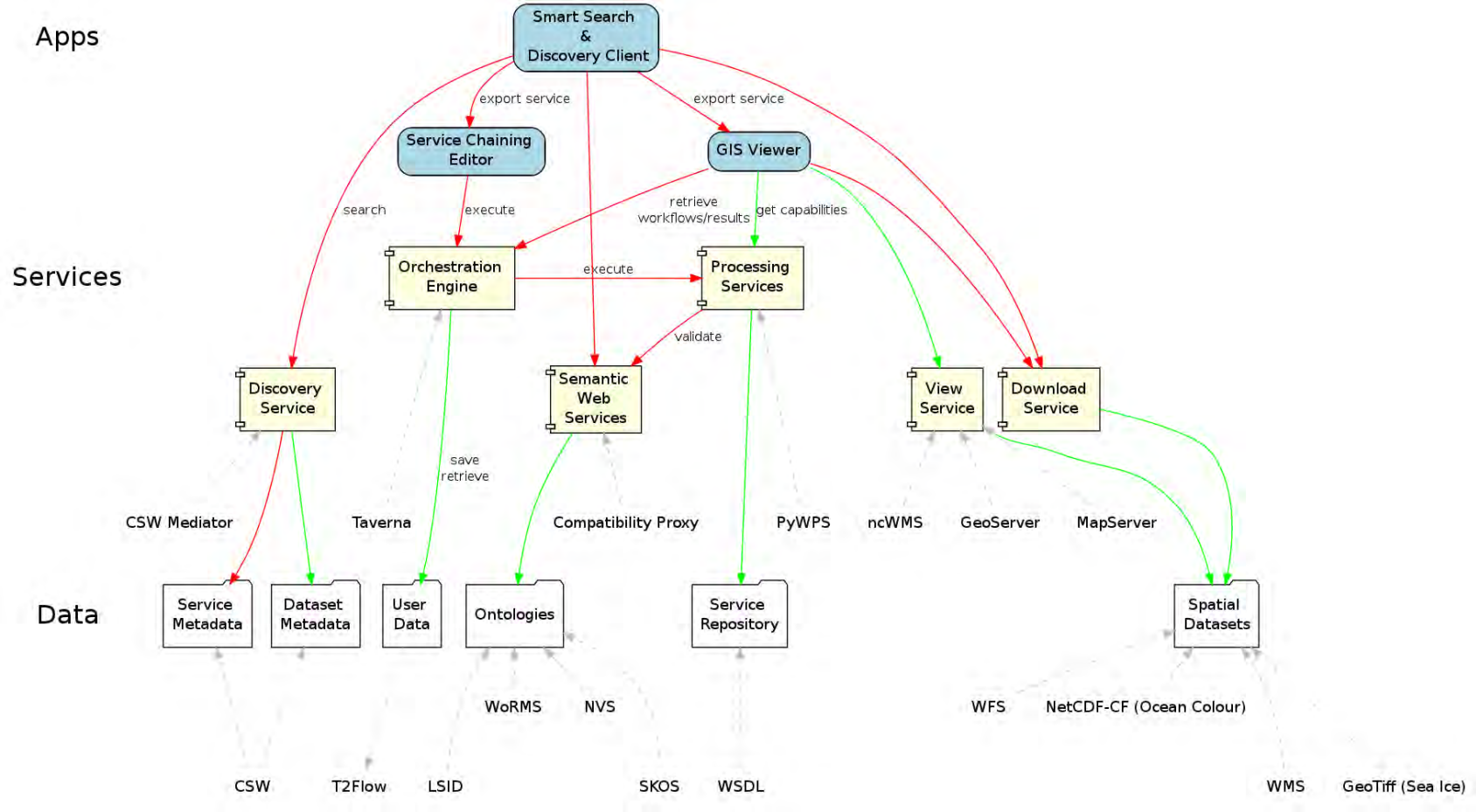
A. Patterson

University College Cork

Coastal & Marine Research Centre

*EGU 2012 – Vienna – 26 April 2012*

# NETMAR


Apps
Smart Search & Discovery Client
export service
export service
Service Chaining Editor
GIS Viewer
search
execute
retrieve workflows/results
get capabilities
Services
Orchestration Engine
execute
Processing Services
validate
Discovery Service
Semantic Web Services
View Service
Download Service
save retrieve
CSW Mediator
Taverna
Compatibility Proxy
PyWPS
ncWMS
GeoServer
MapServer
Data
Service Metadata
Dataset Metadata
User Data
Ontologies
Service Repository
Spatial Datasets
WoRMS
NVS
WFS
NetCDF-CF (Ocean Colour)
CSW
T2Flow
LSID
SKOS
WSDL
WMS
GeoTiff (Sea Ice)

# Definitions

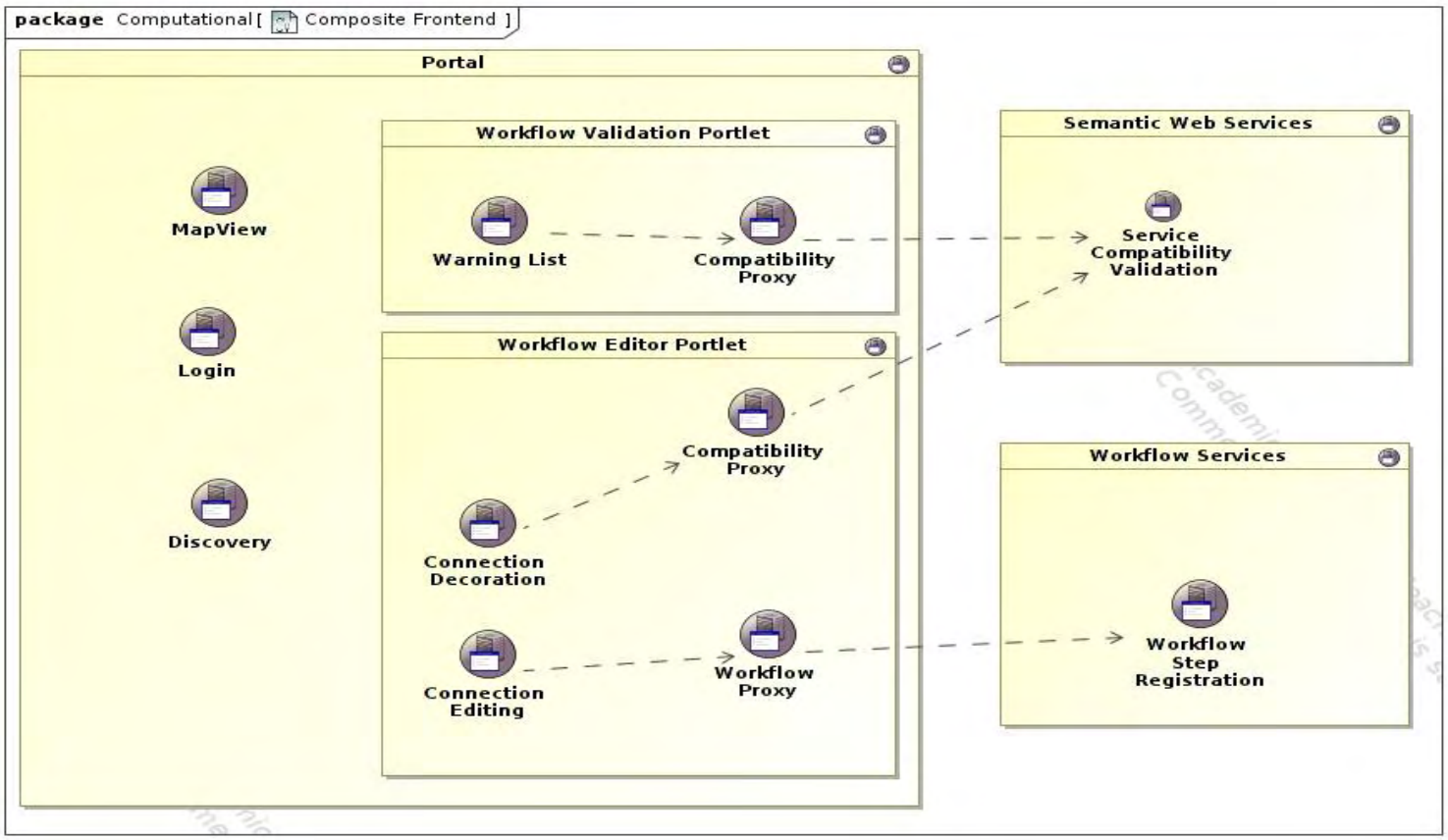
- Architecture
  - Fundamental decisions
  - Meet quality attributes
- Patterns
  - Solution + context
- Service Oriented Architecture
  - Set of patterns
  - Business logic (getting stuff done)

# OO v SOA

- NERC Vocabulary Server
- OO View
  - REST calls, returning XML representing terms
- Service View
  - Governance
  - Authoritativeness
  - Provenance
  - Mapping

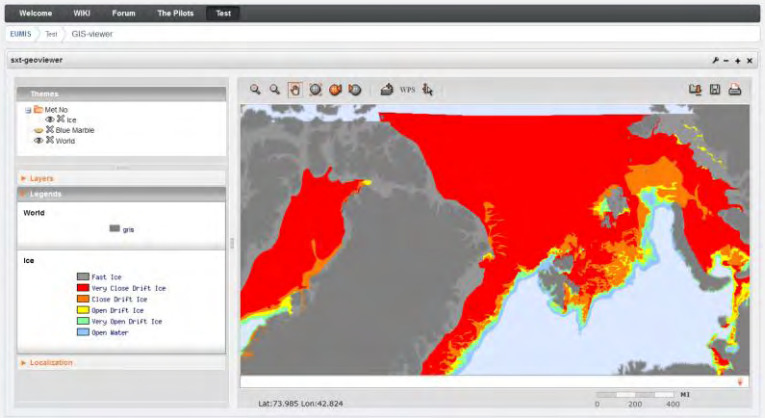
# Composite Front End (Portal)

**How do you we interact with multiple services, get an integrated, cohesive user interface and still preserve SOA principles and modularity benefits?** *Rotem-Gal-Oz - SOA Patterns*

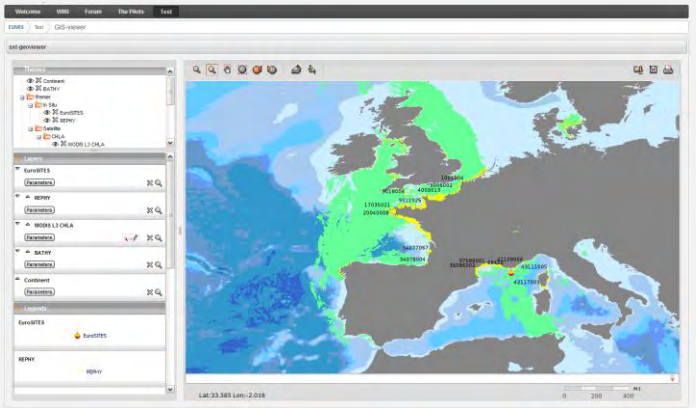


# Multiple User Domains

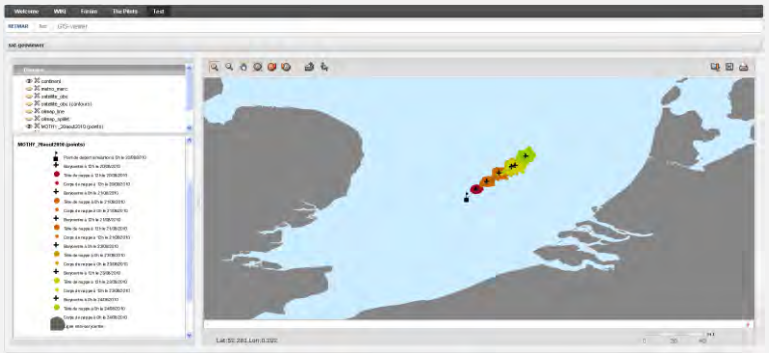
## Ice pilots



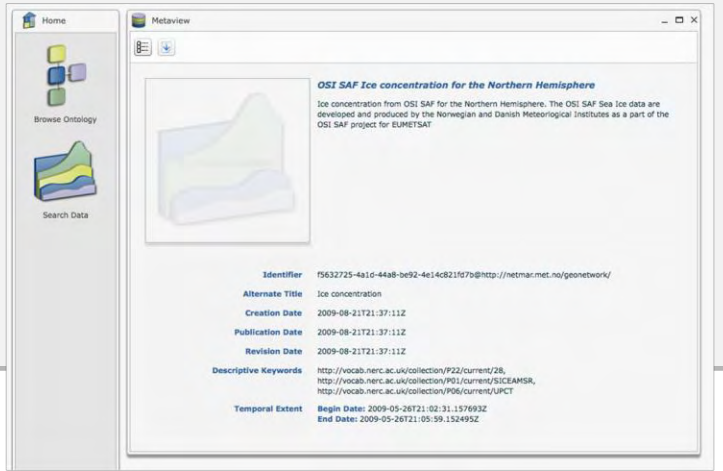

## Oil slick monitoring



## Oceanography

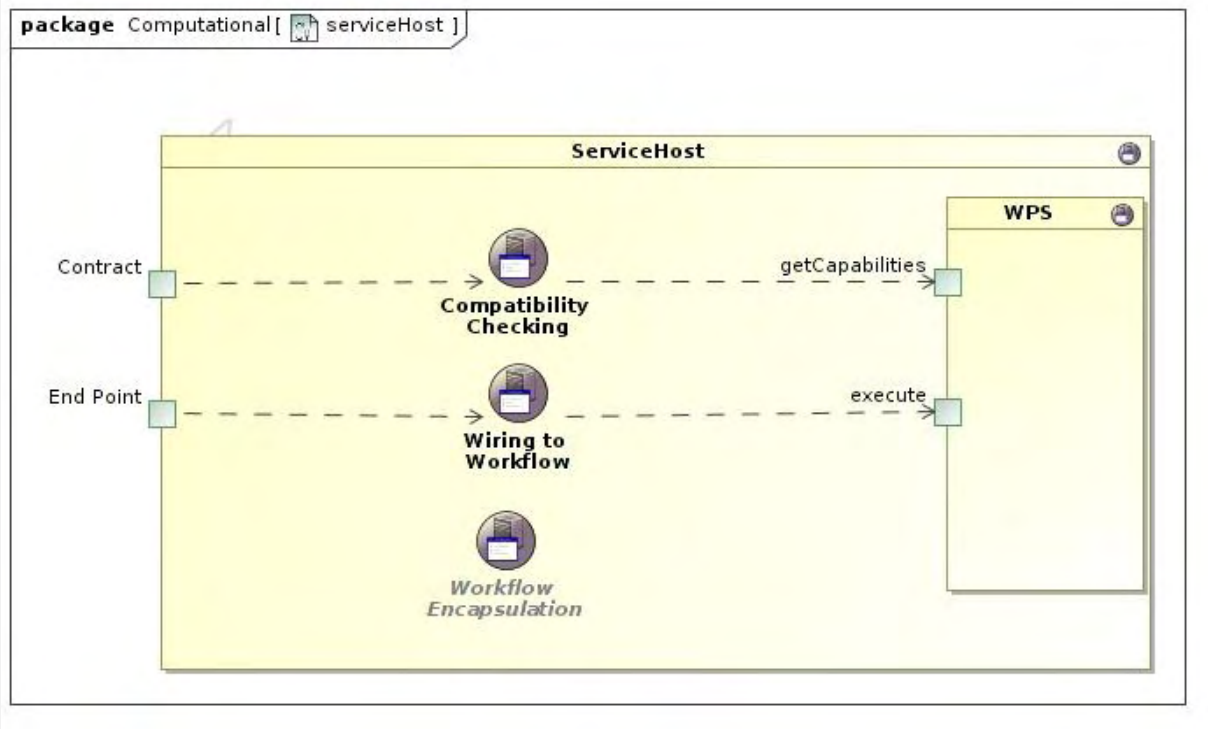


## Coastal Atlas



# Service Host

There needs to be a way to easily configure services, and avoid duplicating the effort of mundane tasks such as setting listeners, and wiring components, for each service.



# Multiple Disciplines

- Geographical / Earth Sciences
  - WPS, Grass GIS modules
- Biological
  - Taverna, MyExperiment

# PBAR

- Patterns Based Architecture Reviews
  - Harrison, Avgeriou, *IEEE Software*
- Focused stakeholder conversation
- Agile approach to architecture
- Checklist based on ATAM General Scenarios
  - Software Engineering Institute

# Conclusion

- Architecture guides conversation
- Emphasise added value over interfaces
- Concrete guidance
- Agile architecture
- Bridge between IT and domain experts

# Thank you, any questions?

*A. Patterson*

*University College Cork*
*Coastal & Marine Research Centre*

A.Patterson@UCC.ie

# NETMAR

## Open Service Network for Marine Environmental Data

### Splinter session SPM1.1 (Weds 25th April 2012, 13:30-15:00. Room SM5)

NETMAR aims to develop a pilot European Marine Information System (EUMIS) for searching, downloading and integrating satellite, in situ and model data from ocean and coastal areas. It will be a user-configurable system offering flexible service discovery, access and chaining facilities using OGC, OPeNDAP and W3C standards. It will use a semantic framework coupled with ontologies for identifying and accessing distributed data, such as near-real time, forecast and historical data. EUMIS will also enable further processing of such data to generate composite products and statistics suitable for decision-making in diverse marine application domains.

At this public splinter meeting, we present the results of our project.

| | |
|---|---|
| **1. NETMAR Overview** | **Adam Leadbetter, NERC** |
| **2. User interaction and pilot studies** | **Torill Hamre, NERSC** |
| **3. Building the system architecture** | **Anthony Patterson, CMRC** |
| **4. What faceted search and ontologies have done for us** | **Cyndy Chandler, BCO-DMO, Woods Hole** |
| **5. Building the NETMAR semantic resource** | **Adam Leadbetter, NERC** |
| **6. Why worry about uncertainty** | **Dan Cornford, Aston University** |
| **7. NETMAR services** | **Jorge de Jesus, Plymouth Marine Lab.** |
| **8. Demonstrations** | |

SEVENTH FRAMEWORK PROGRAMME

# NETMAR

## Overview

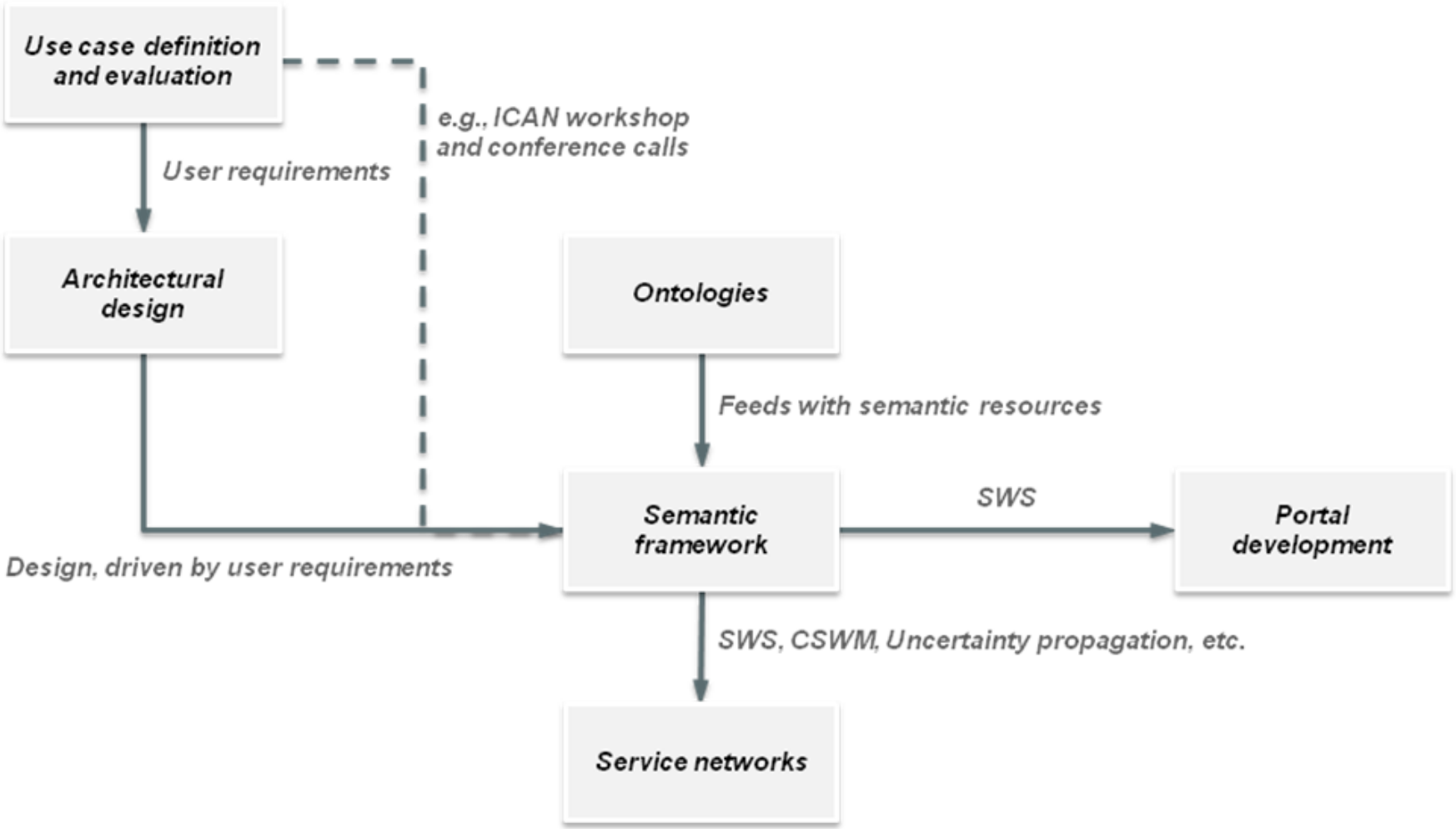
# Project aims

- Build a European Marine Information System portal
  - Driven by pilot studies
  - Discovery of data and services
  - Service chaining

# Pilot studies

- Arctic sea ice observations
- Near-real time oil spill monitoring
- Ocean Colour
- International Coastal Atlas Network

# Project structure



# Project links

- Project website http://netmar.nersc.no/

- EUMIS Portal (under development)

  http://nport.nersc.no:8080/

# User interaction and pilot studies

Torill Hamre <torill.hamre@nersc.no>

*NETMAR Public Splinter Meeting – Vienna – 25 April 2012*

# Outline

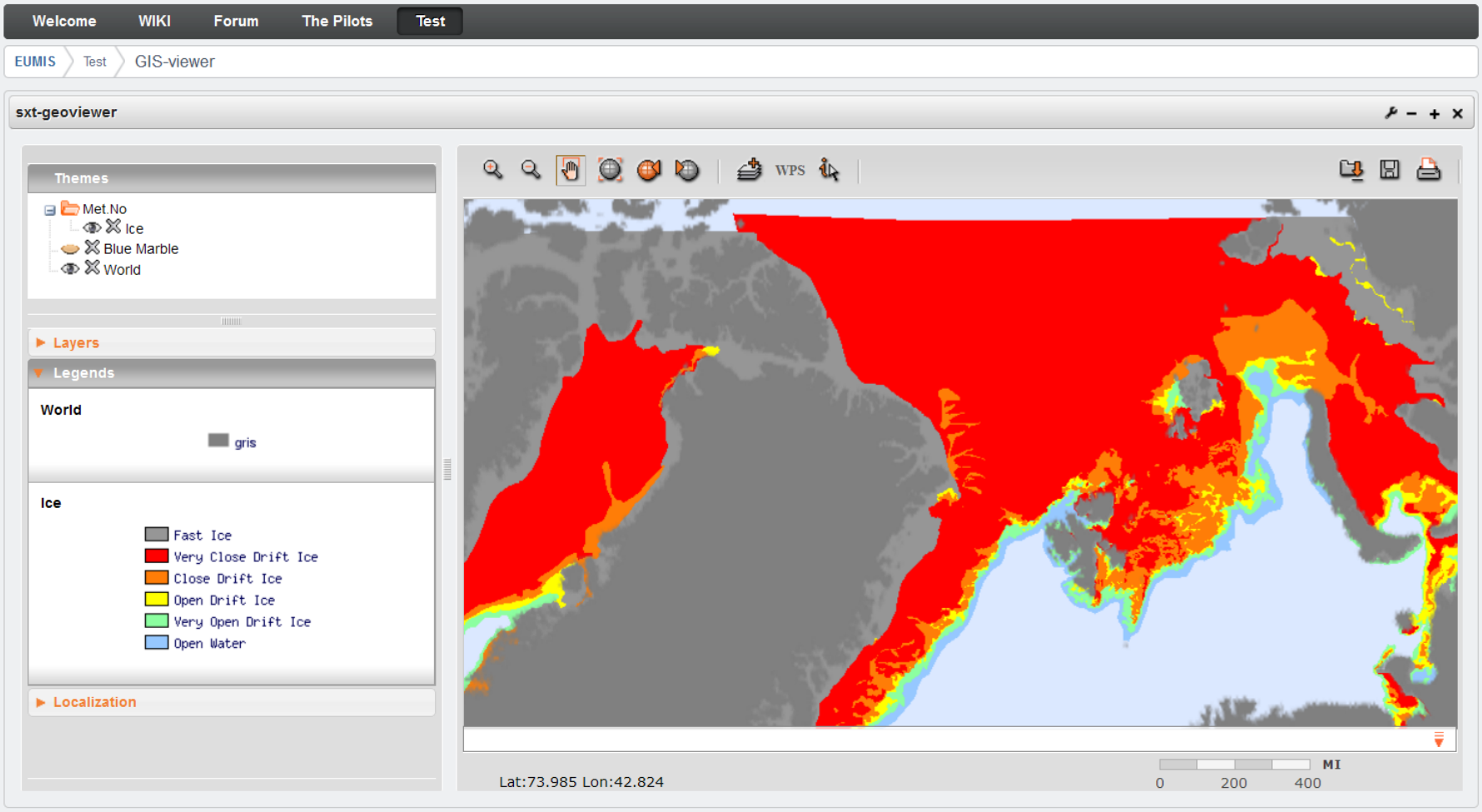
- Pilots in NETMAR
  1. Arctic Sea Ice monitoring and forecasting
  2. Oil spill forecasting and shoreline cleanup
  3. Ecosystem monitoring and modelling
  4. ICAN (International Coastal Atlas Network)
- User interaction

# Pilots in NETMAR

- All pilots are defined by real users working in the domains of
  - Arctic sea ice monitoring and forecasting
  - Oil spill forecasting and mitigation
  - Ecosystem monitoring and modelling
  - Coastal Web Atlas and “smart search”

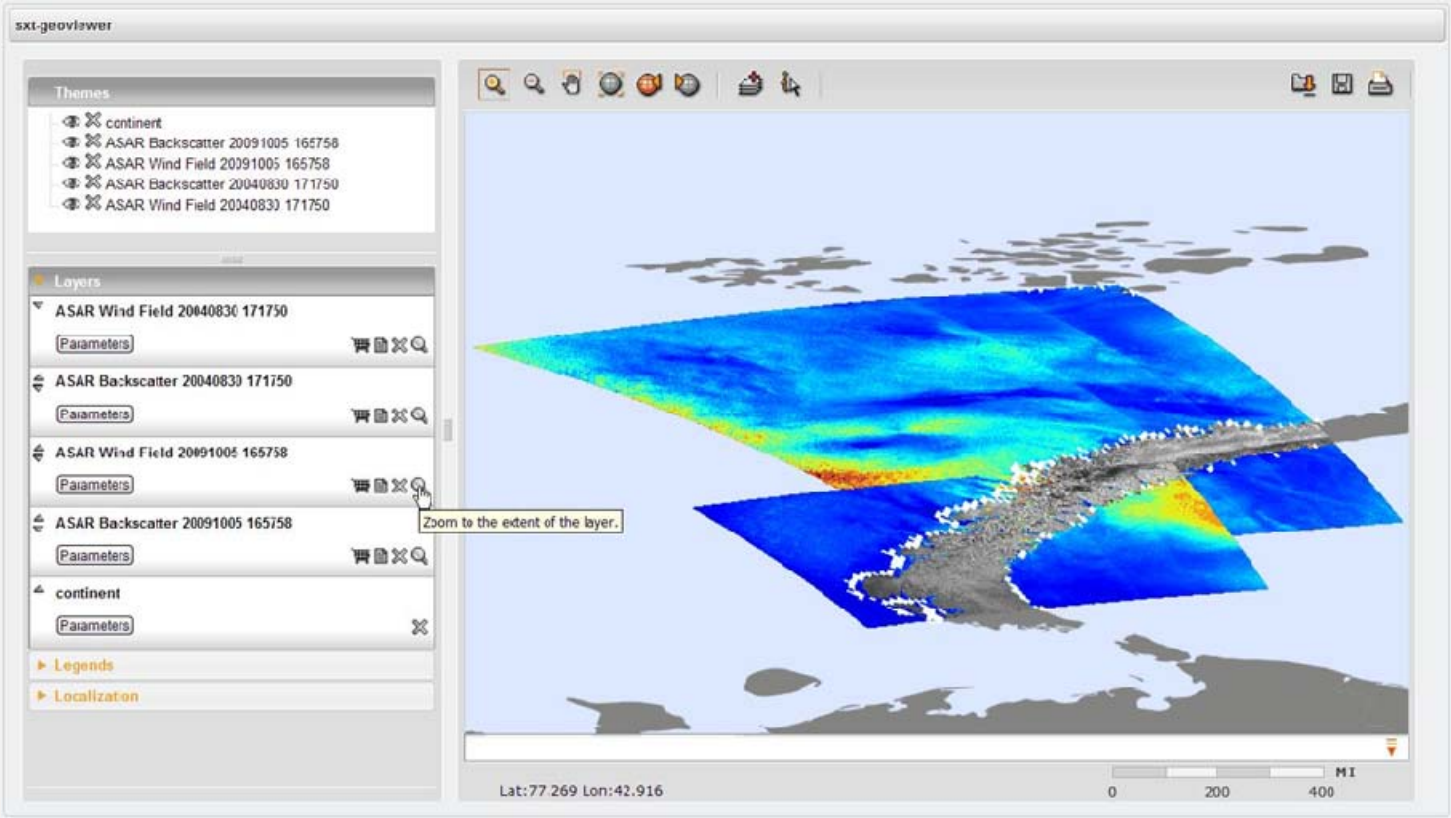
# Pilot 1 – Arctic Sea Ice

- Retrieving latest ice information



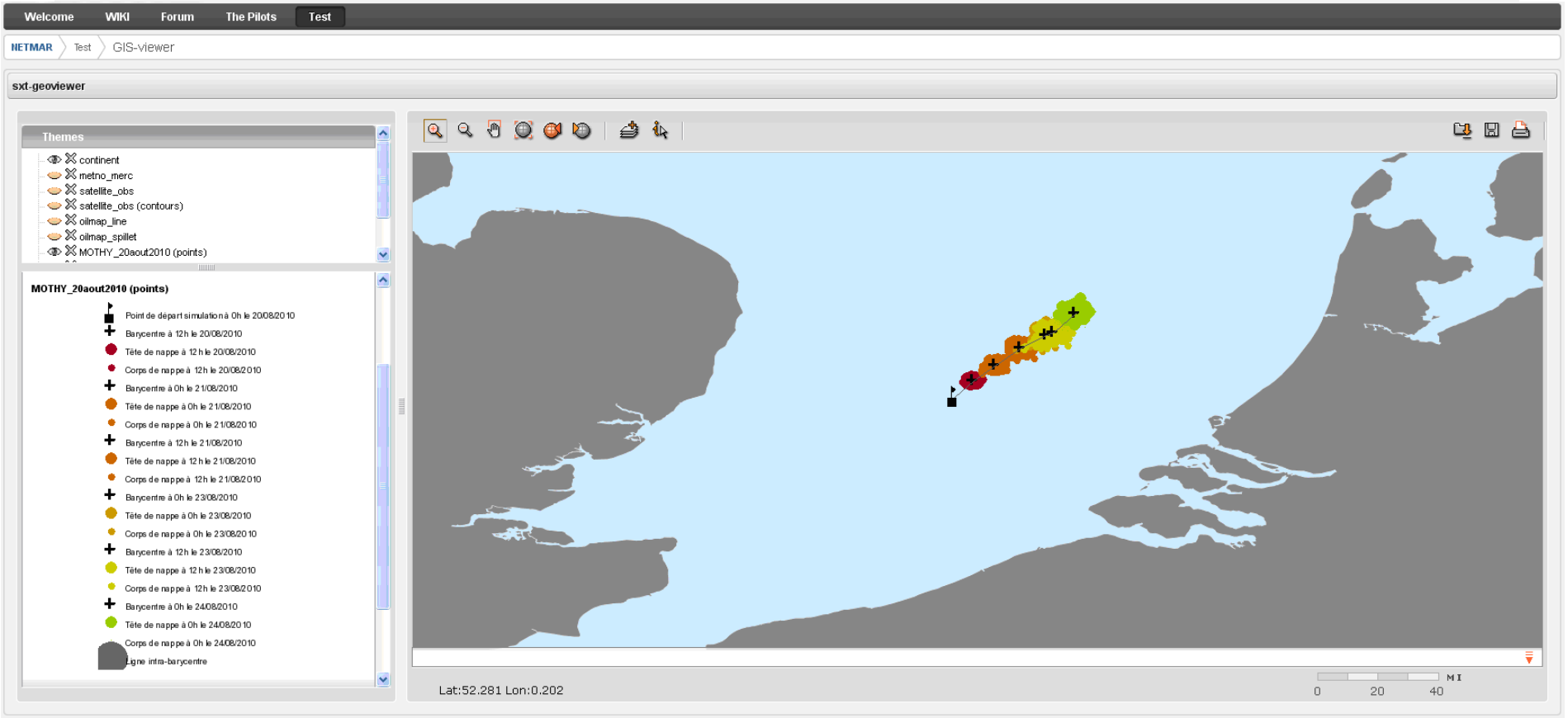
# Pilot 1 – Arctic Sea Ice

- Viewing historical data



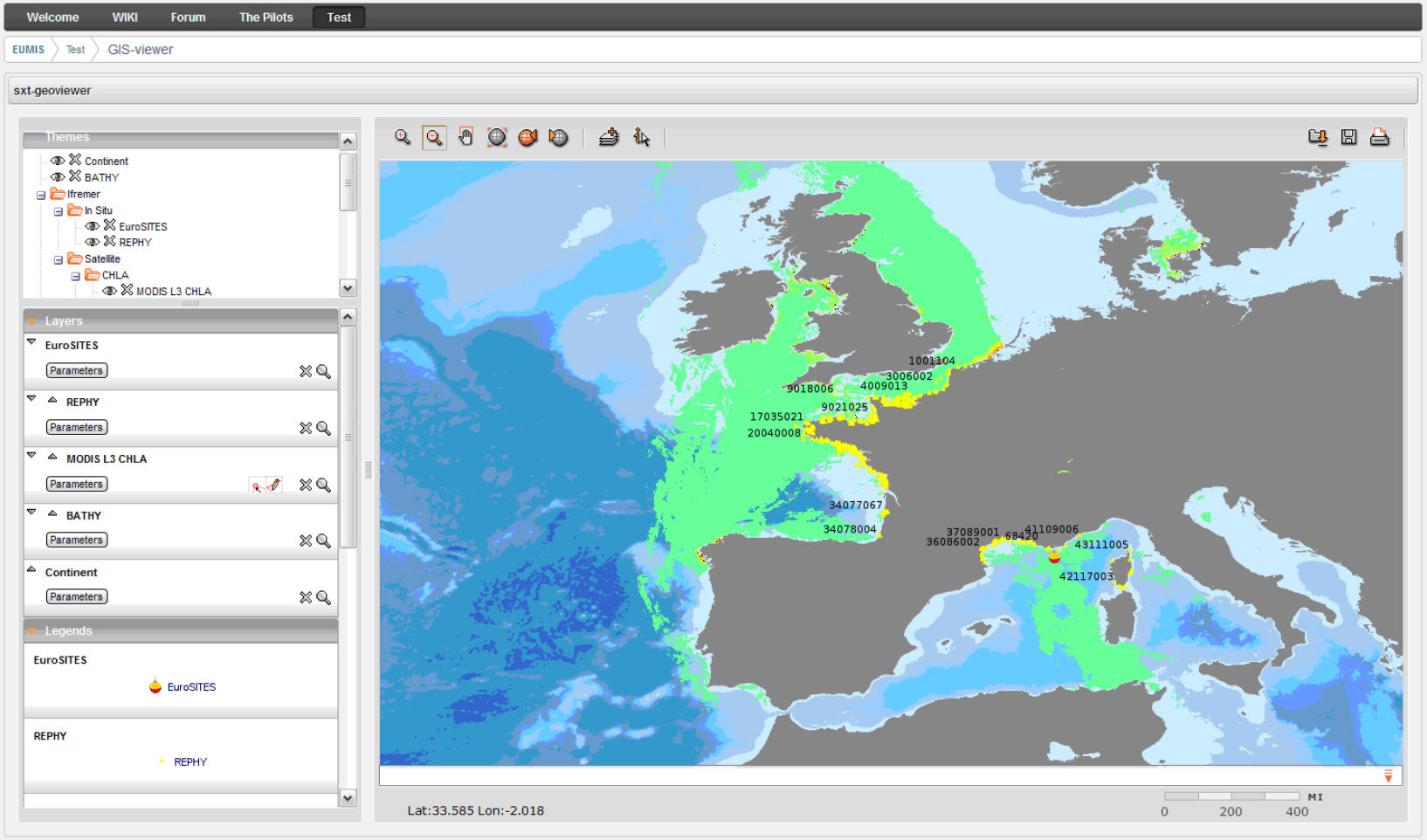
# Pilot 2 – Oil Spill Forecasting

- Combining multiple oil spill drift models



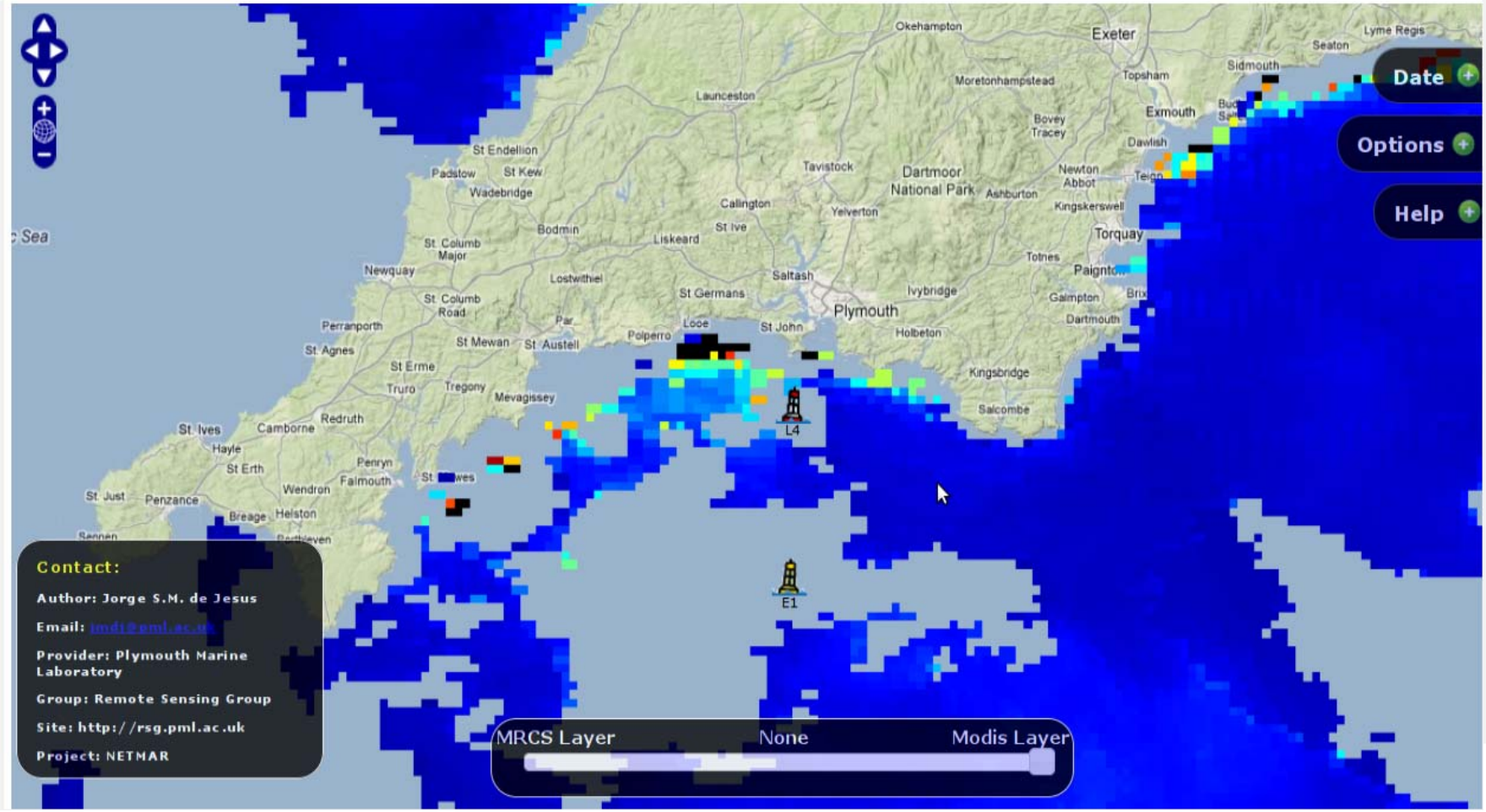
# Pilot 3– Ecosystem

- Combining remote sensing and in situ data



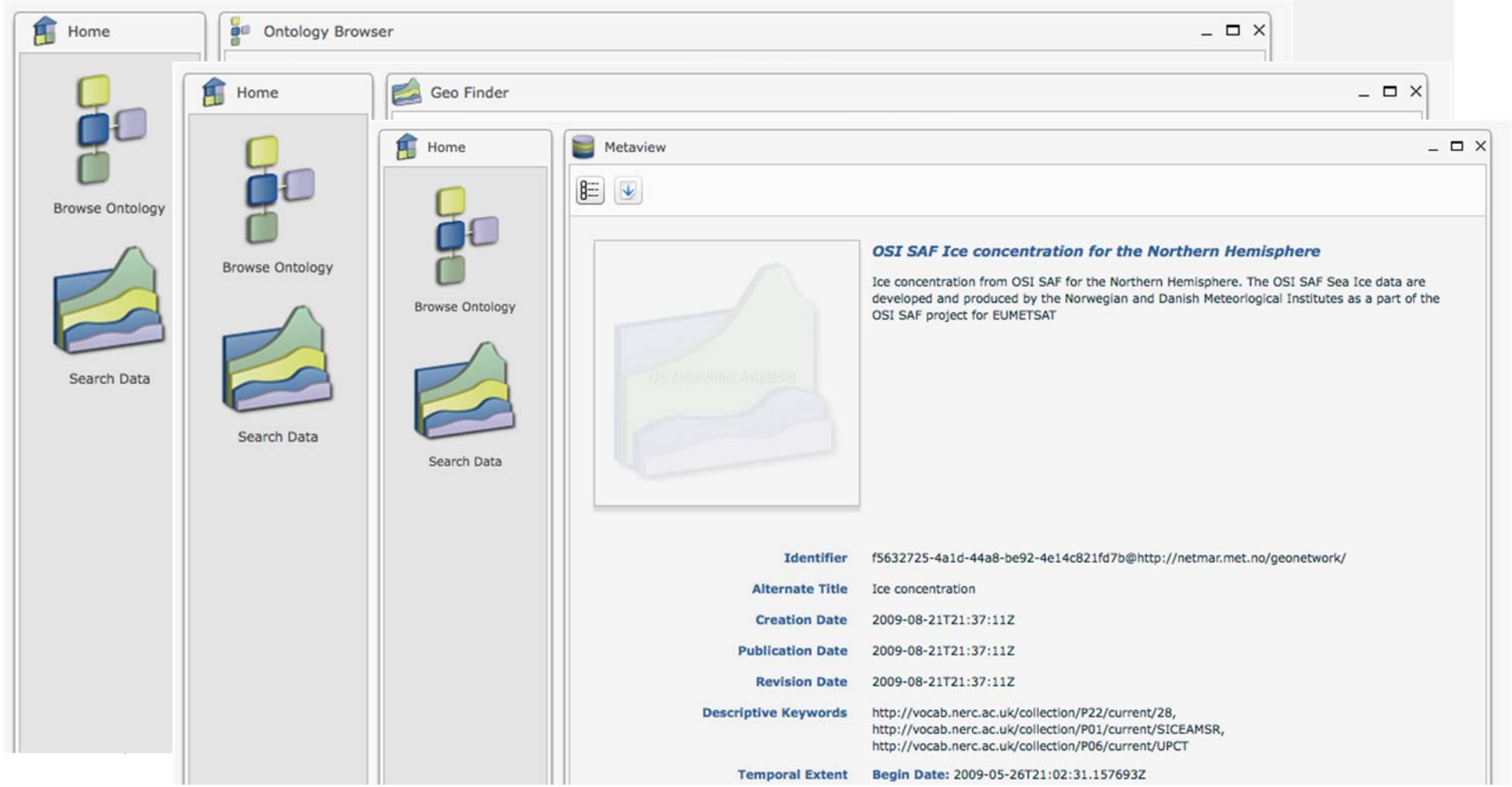
# Pilot 3– Ecosystem

- Computing on the fly with WPS



# Pilot 4 – ICAN

- “Smart search” in Coastal Web Atlases



# User interaction

- User requirements definition
  - Interviews and informal meetings in 2010-2011
  - Specified a set of scenarios in each pilot
- First version of EUMIS
  - Tested by selected users in fall 2011
  - Gave valuable feedback for improving services and systems
- Second version of EUMIS
  - Ready for testing from May and onwards
  - We’re open for more test users!

# Thank you!

Torill Hamre <torill.hamre@nersc.no>

*Nansen Environmental and Remote Sensing Center (NERSC), Bergen, Norway*

# Building the NETMAR System Architecture

Anthony Patterson

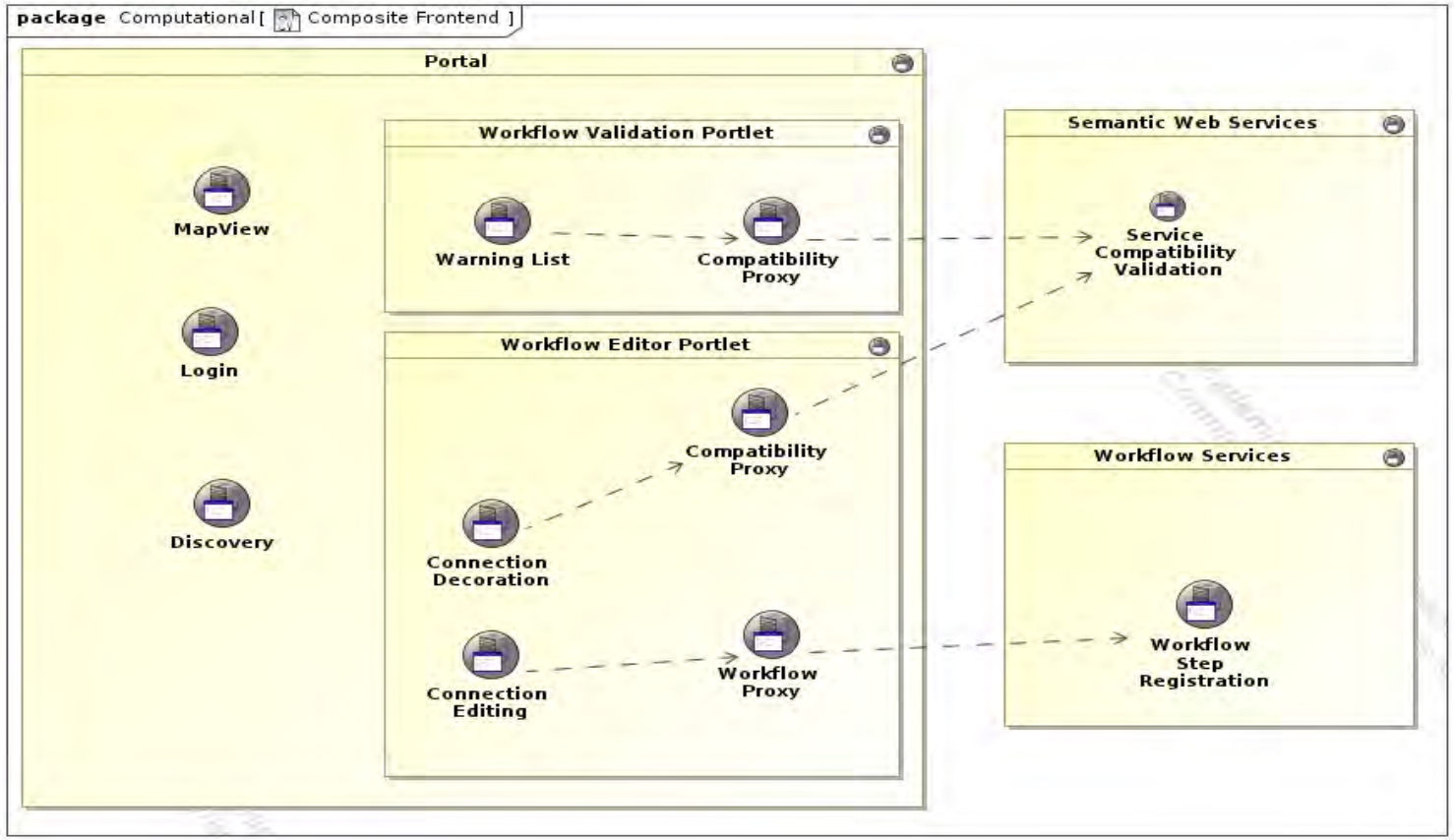
University College Cork

Coastal & Marine Research Centre

*EGU 2012 – Vienna – 26 April 2012*

# Composite Front End (Portal)

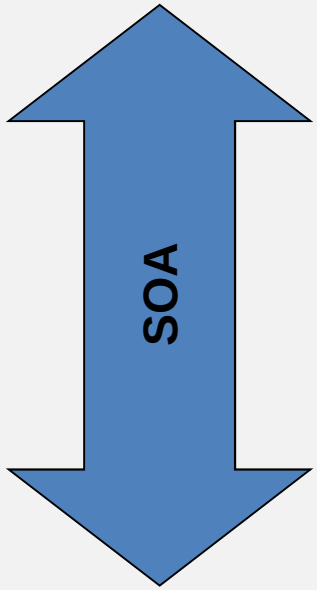
**How do you we interact with multiple services, get an integrated, cohesive user interface and still preserve SOA principles and modularity benefits?**



# Motivations

- Operational Autonomy
- Avoid vendor lockin
- Reuse

- Discovery
- Compose new services




- Easy to learn

# Patterns based reviews

- Patterns Based Architecture Reviews
- + SOA Patterns
- Teleconferences
- Email discussions
- Identify Tradeoffs, Risks
- Quality Attribute checklist

# BCO-DMO
# DATA DISCOVERY

Cyndy Chandler

25 April 2012

NetMAR Focus Group

EGU, Vienna, Austria

# Shifting expectations

1. 1980 Experiment data
2. 1990 Project data
3. 2000 Program data
4. 2010 Global data

# /jgofs/arabian/INVENTORY --cruise_id eq TTN043-- Level 1

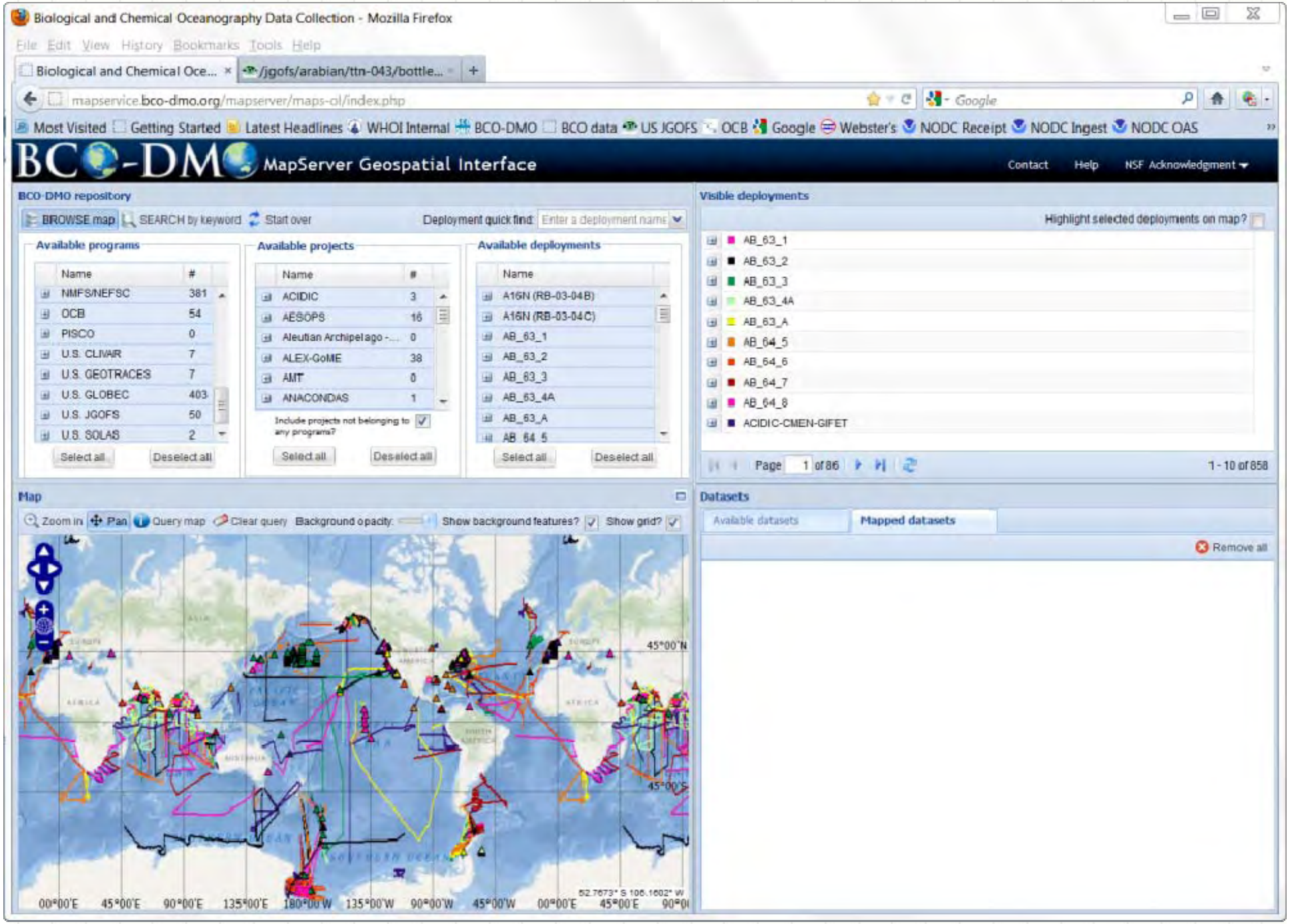
Directory | Documentation | Download & Other Operations

Level 0 | Next Level | Flat Listing

US JGOFS Arabian Sea Project data

```
#  Arabian Sea Inventory
#  version December 16, 2002
#
#  DMO note: March 2007: added links to data entitites
#            October 2009: added TT039 cruise data links
#
#  Notes regarding data not yet submitted to U.S. JGOFS Data Management Office
#     n = no data available; y = data available from relational database
#     n1 = data not submitted; PI retired prior to submitting data
#
=========================
ship         cruise_id   cruise_name
-------------------------
T_Thompson   TTN043      Process1
=========================
```

| PI | co-PI | data_sampled | submitted | on_system | data_entity |
|---|---|---|---|---|---|
| Roman | nd | cruise event log | y | y | event log |
| Azam | Smith | Bacteria | y | y | bacteria |
| Azam | Smith | POC PON | y | y | poc pon |
| Barber | Marra | Primary Prod insitu | y | y | primary prod |
| Bender | Dickson | O2 Prod insitu | y | y | insitu O2 prod |
| Bender | Dickson | O2 Prod ondeck | y | y | ondeck O2 prod |
| Buesseler | nd | Thorium;POC;PON pump | y | y | th234 pump |
| Campbell | Landry | Picoplankton;flow cytometry | y | y | picoplankton |
| Caron | nd | Microzooplankton grazing | y | y | grazing |
| Caron | nd | Microplankton;abundance and biomass | y | y | microplankton |
| Caron | nd | Nanoplankton;abundance and biovolume | y | y | nanoplankton |
| Codispoti | Morrison | Bottle nutrient data | y | y | bottle |
| DMO | nd | Trace Metal bottle cast information | y | y | TMbottle |
| Gardner | Morrison | Mixed layer depths | y | y | mixed layer |
| Gardner | Richardson | Aggregates pmc | y | y | pmc |
| Garside | nd | Nanomolar conc nitrate | y | y | low level NO3 |
| Goericke | nd | Phytoplankton pigments | y | y | HPLC pigments |
| Goyet | nd | pCO2 air | y | y | pco2 air |
| Goyet | nd | pCO2 water | y | y | pco2 water |
| Goyet | nd | TCO2 and total alkalinity | y | y | tco2 |
| Hansell | nd | TON | y | y | ton |
| Marra | nd | PAR | y | y | PAR |
| McCarthy | nd | Ammonium | y | y | ammonium |
| McCarthy | nd | N15 daily uptake sum | y | y | areal sum |
| McCarthy | nd | N15 uptake rates | y | y | N15 uptake |
| Measures | nd | Dissolved Fe and Al | y | y | TMtrace Fe Al |
| Morrison | Codispoti | CTD measurements | y | y | ctd |
| Peltzer | Hansell | DOC TOC | y | y | toc |
| Roman | nd | Mesozooplankton Bongo | y | y | mesozoo bongo |
| Roman | nd | Mesozooplankton MOC | y | y | mesozoo moc |


Biological and Chemical Oceanography Data Collection - Mozilla Firefox
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BCO-DMO MapServer Geospatial Interface
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BCO-DMO repository
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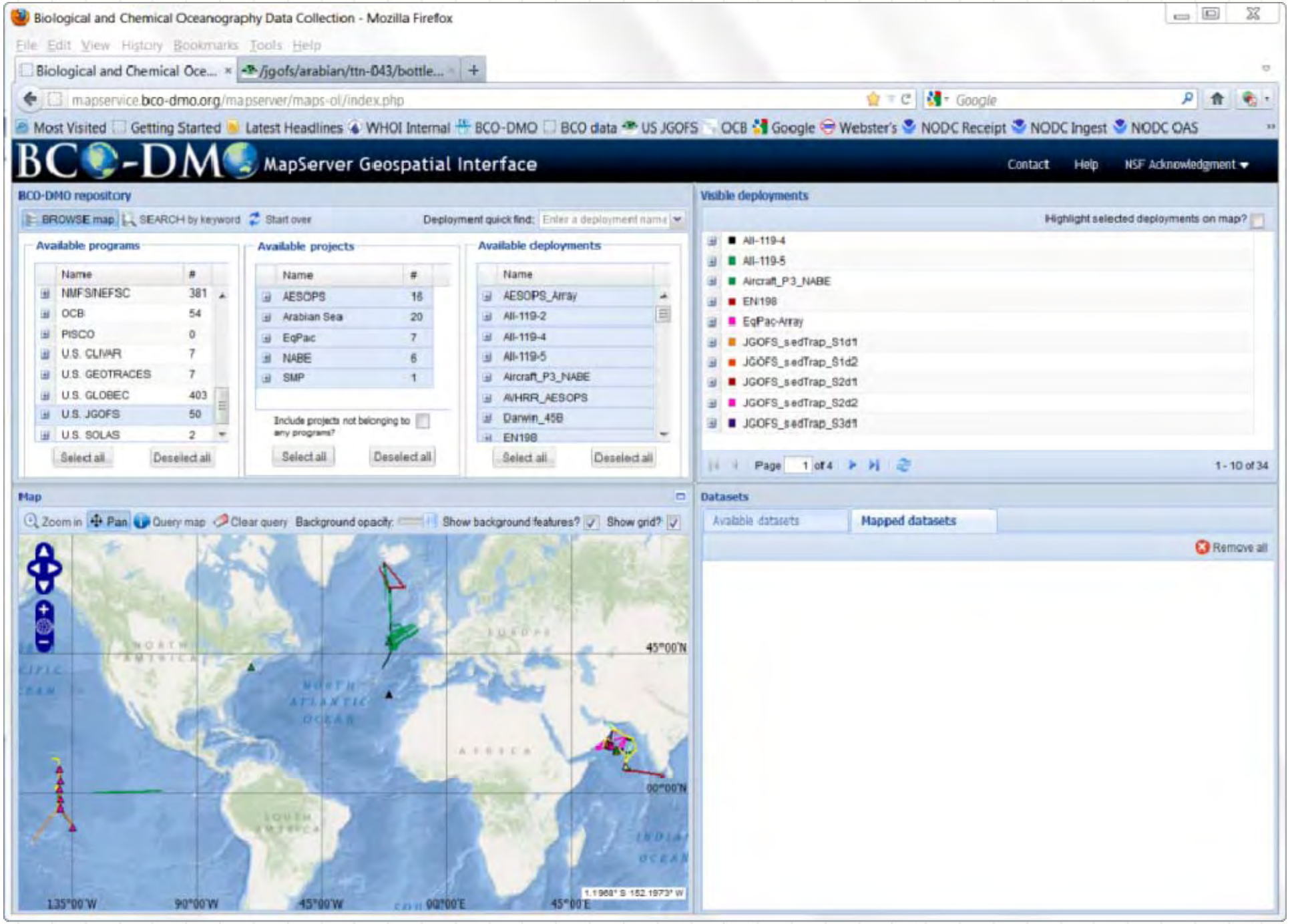
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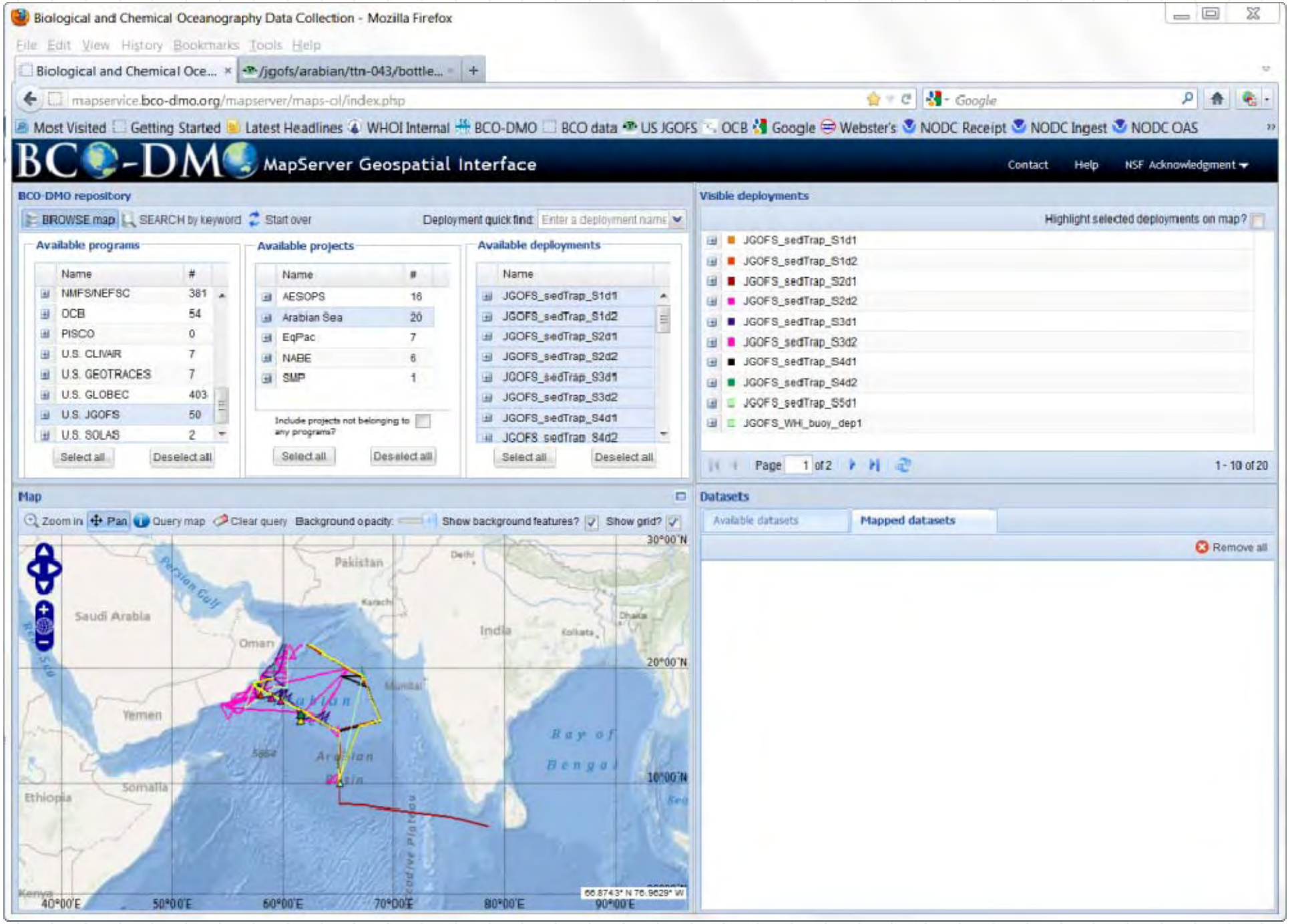
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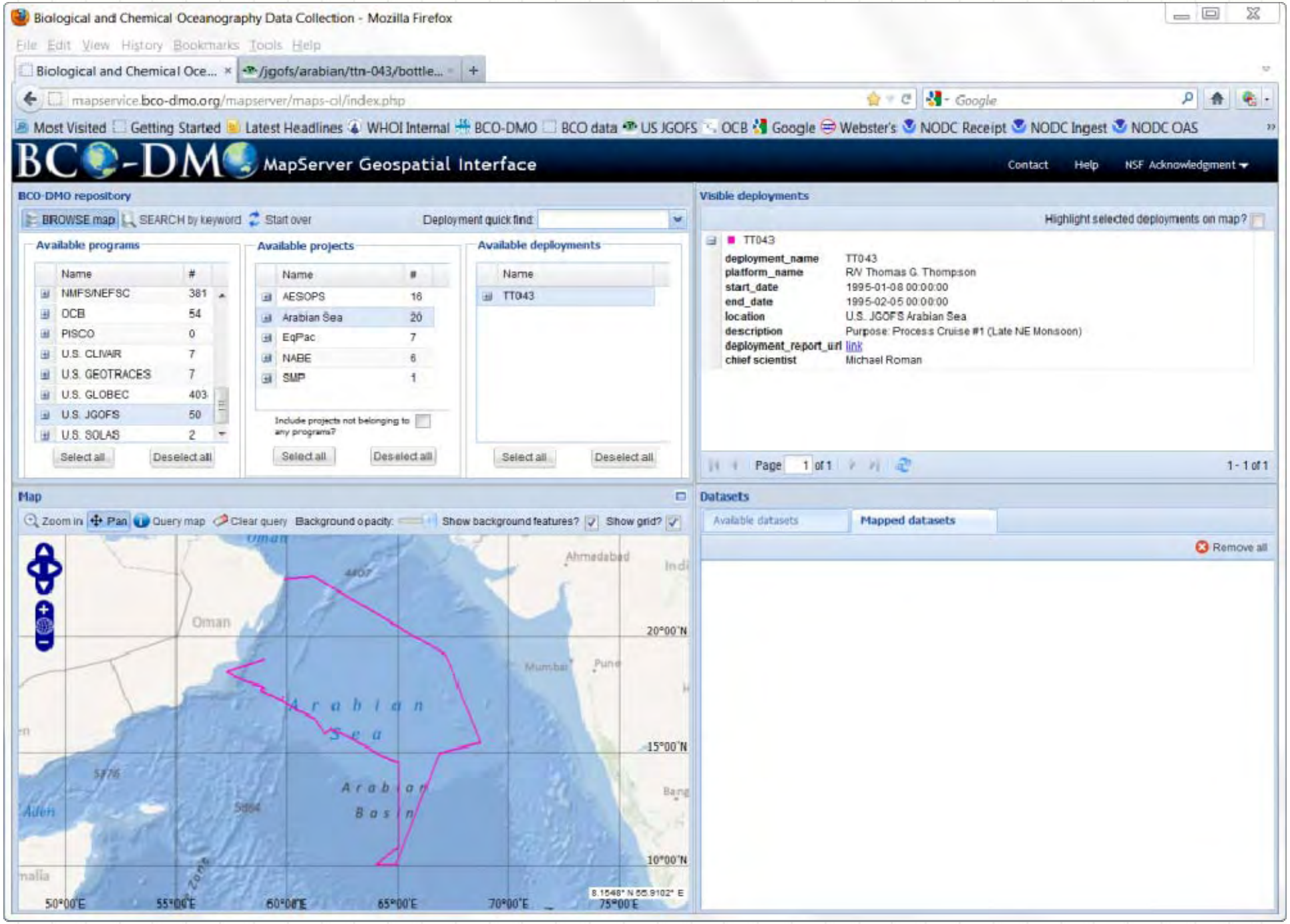
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end_date 1995-02-05 00:00:00
location U.S. JGOFS Arabian Sea
description Purpose: Process Cruise #1 (Late NE Monsoon)
deployment_report_url link
chief scientist Michael Roman
Page 1 of 1
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Pune
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50°00'E
55°00'E
60°00'E
65°00'E
70°00'E
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Available datasets
Mapped datasets
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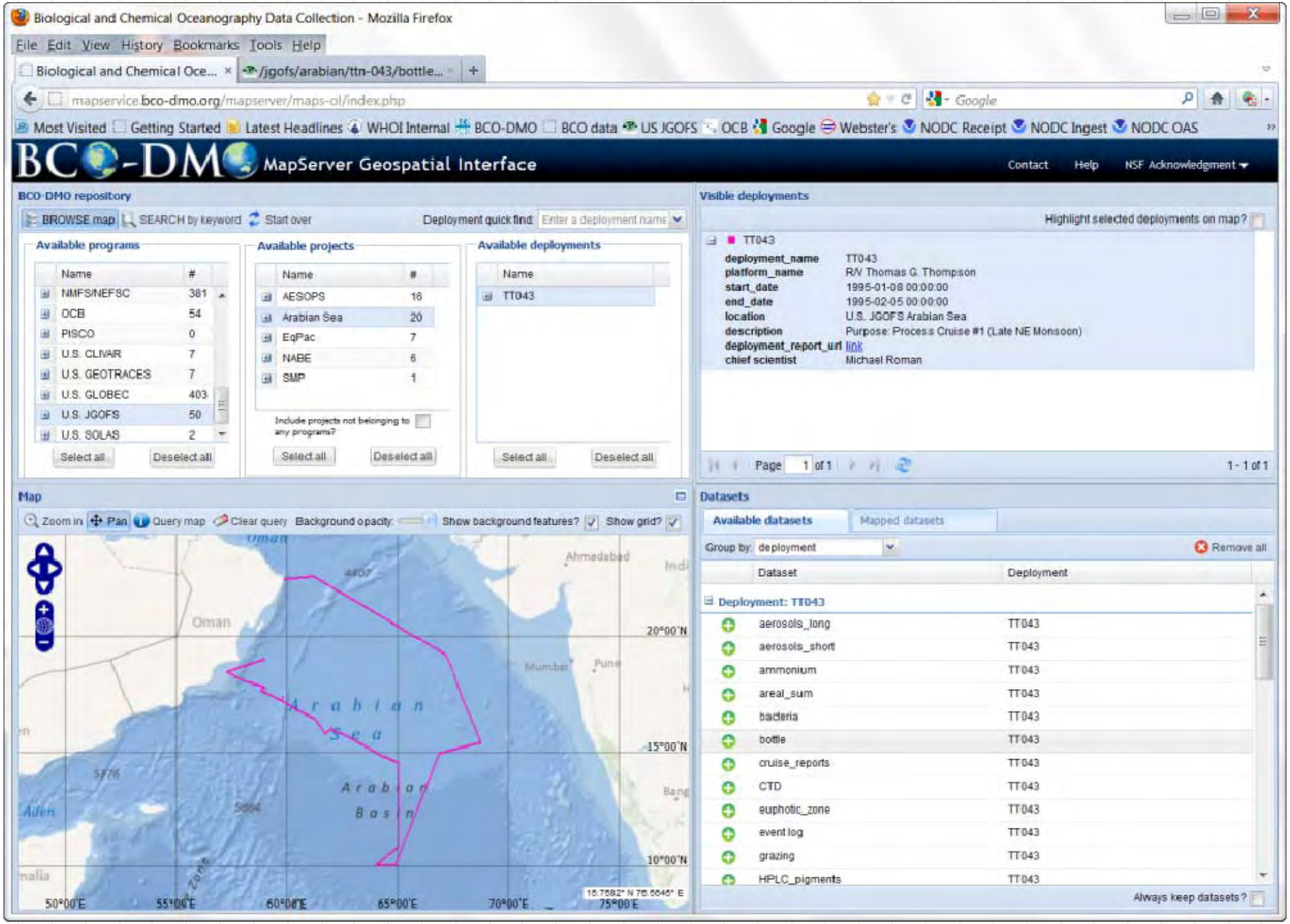
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Most Visited Getting Started Latest Headlines WHOI Internal BCO-DMO BCO data US JGOFS OCB Google Webster's NODC Receipt NODC Ingest NODC OAS
BCO-DMO MapServer Geospatial Interface
Contact Help NSF Acknowledgment
BCO-DMO repository
BROWSE map SEARCH by keyword Start over
Deployment quick find: Enter a deployment name
Available programs
Name # NMFS/NEFSC 381 OCB 54 PISCO 0 U.S. CLIVAR 7 U.S. GEOTRACES 7 U.S. GLOBEC 403 U.S. JGOFS 50 U.S. SOLAS 2
Select all Deselect all
Available projects
Name # AESOPS 16 Arabian Sea 20 EqPac 7 NABE 6 SMP 1
Include projects not belonging to any programs?
Select all Deselect all
Available deployments
Name TT043
Select all Deselect all
Visible deployments
Highlight selected deployments on map?
TT043
deployment_name TT043
platform_name R/V Thomas G. Thompson
start_date 1995-01-08 00:00:00
end_date 1995-02-05 00:00:00
location U.S. JGOFS Arabian Sea
description Purpose: Process Cruise #1 (Late NE Monsoon)
deployment_report_url link
chief scientist Michael Roman
Page 1 of 1
1 - 1 of 1
Map
Zoom in Pan Query map Clear query Background opacity: Show background features? Show grid?
Oman
Ahmedabad
Arabian Sea
Arabian Basin
Mumbai
Pune
Aden
20°00'N
15°00'N
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65°00'E
70°00'E
75°00'E
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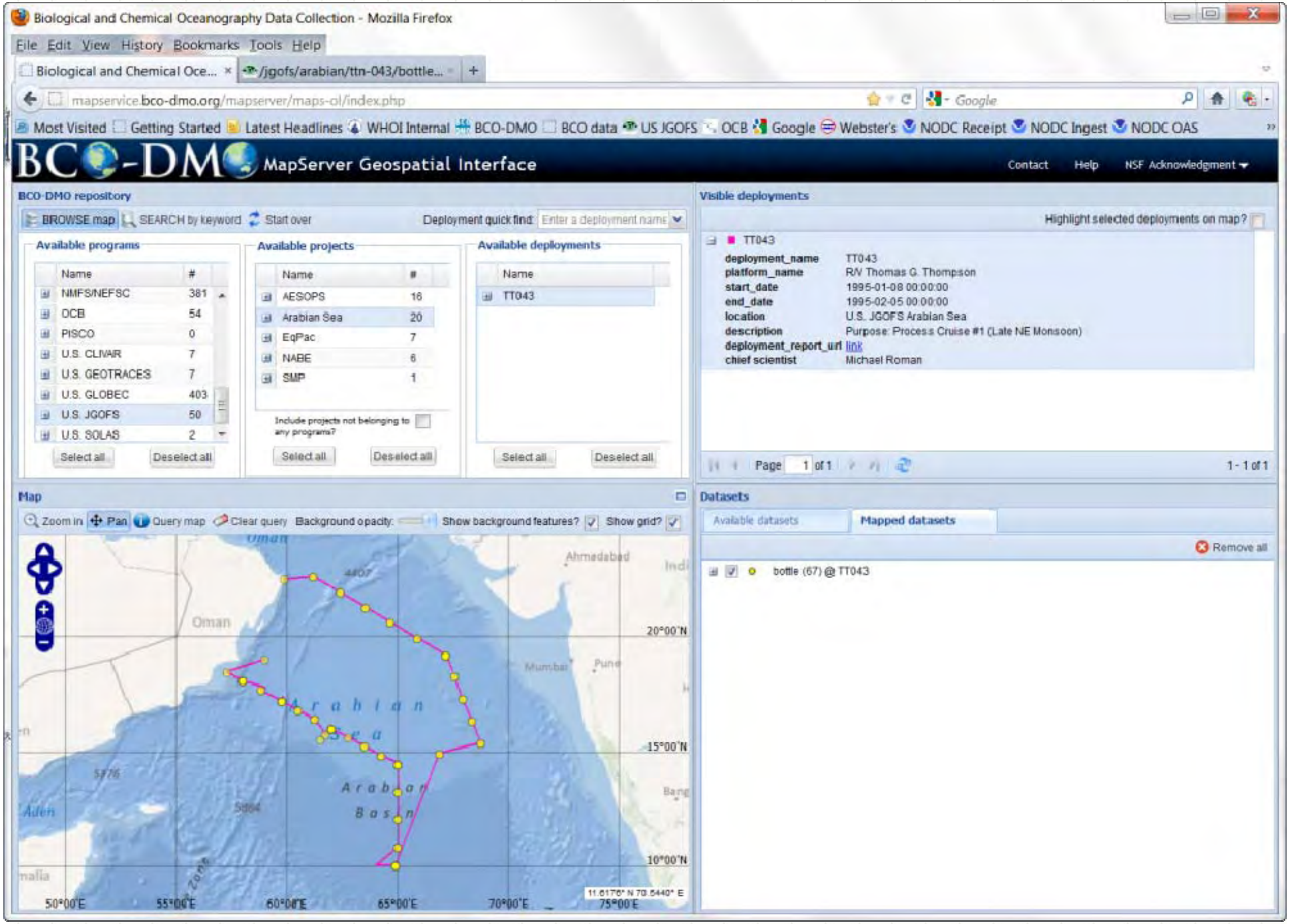
Available datasets Mapped datasets
Group by: deployment
Remove all
Dataset Deployment
Deployment: TT043
aerosols_long TT043
aerosols_short TT043
ammonium TT043
areal_sum TT043
bacteria TT043
bottle TT043
cruise_reports TT043
CTD TT043
euphotic_zone TT043
event log TT043
grazing TT043
HPLC_pigments TT043
Always keep datasets?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Zoom in Pan Query map Clear query Background opacity: Show background features? Show grid?
Oman
Ahmedabad
Mumbai
Pune
Aden
Arabian Sea
Arabian Basin
20°00'N
15°00'N
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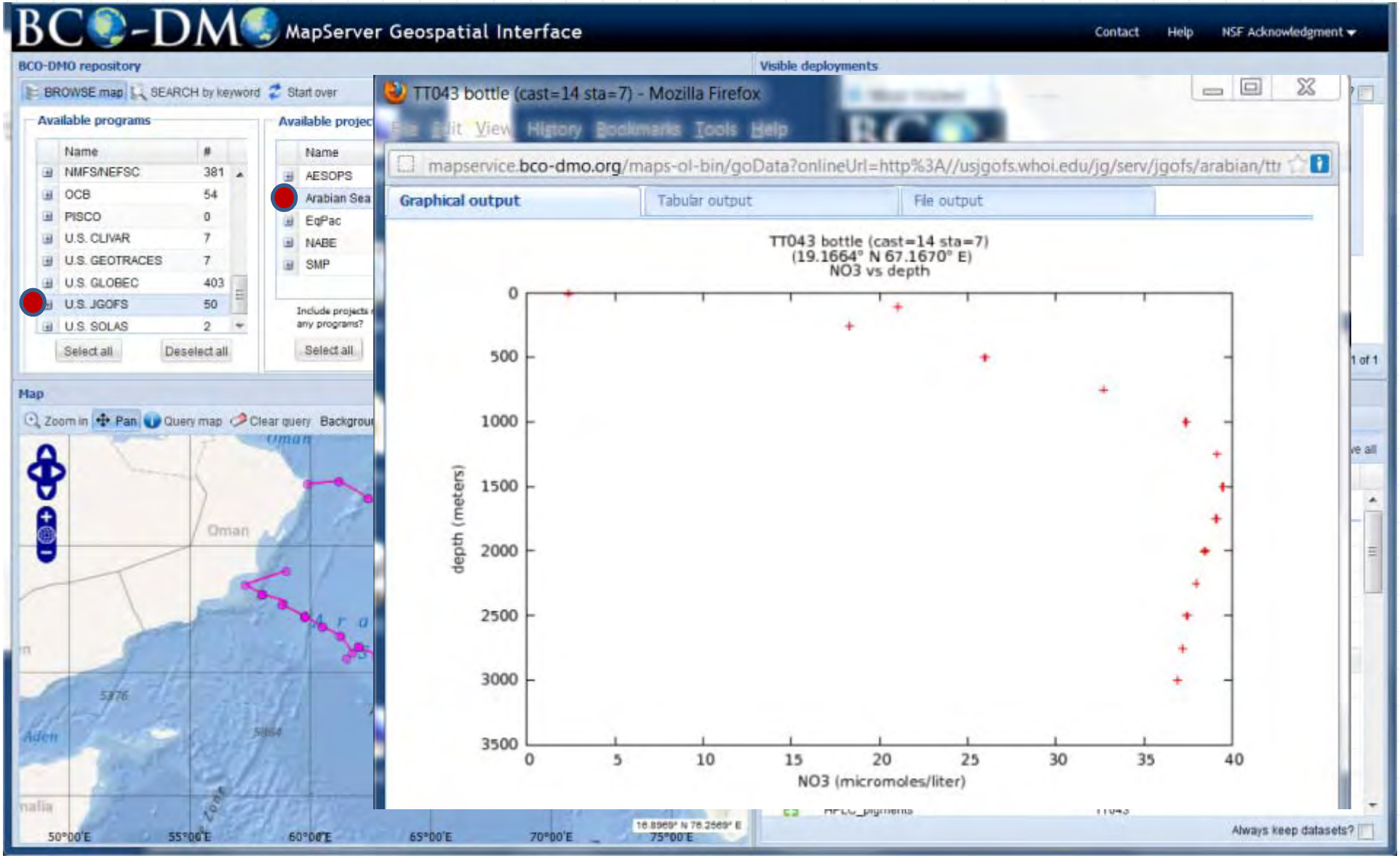
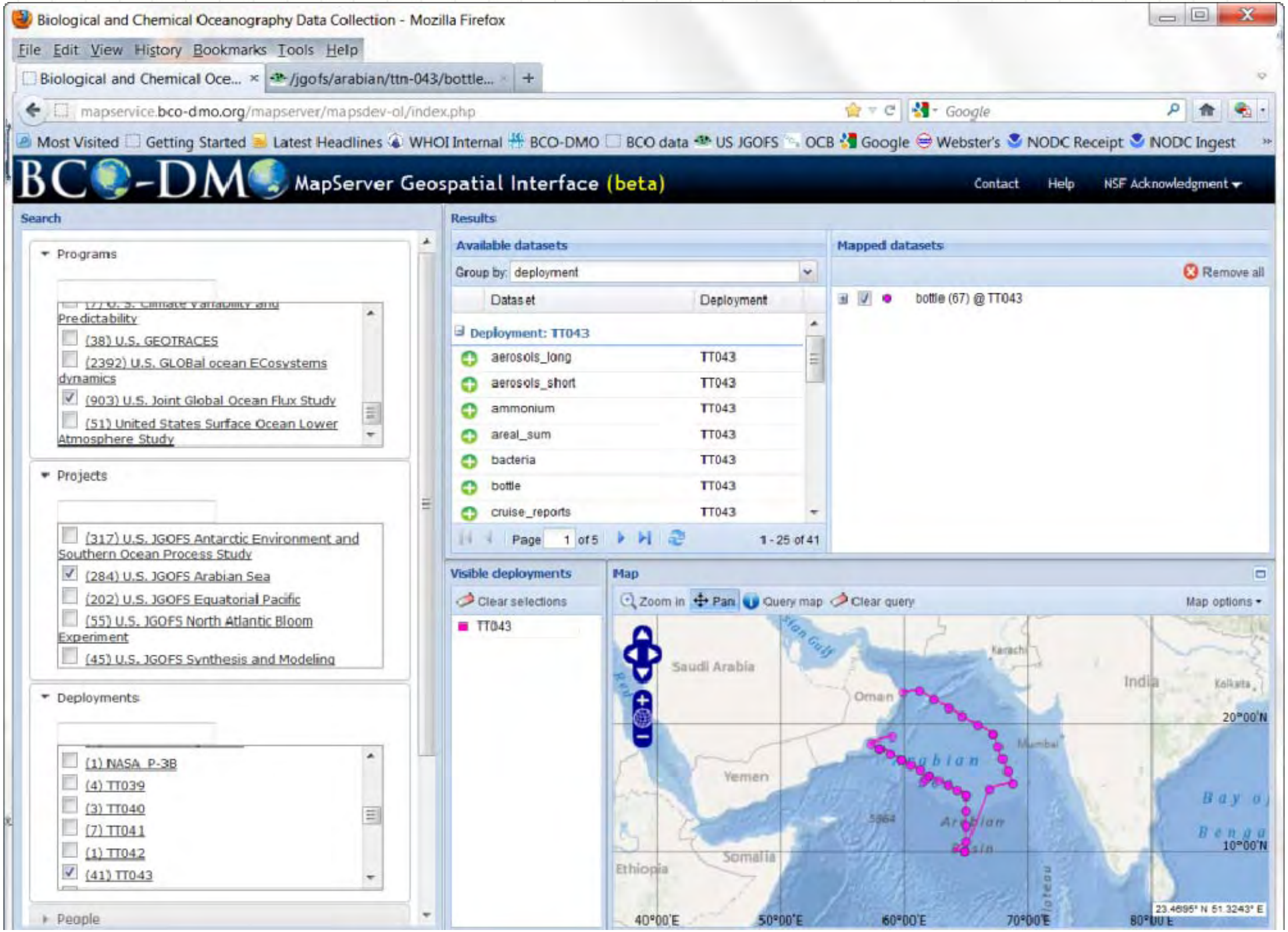
65°00'E
70°00'E
75°00'E
Datasets
Available datasets Mapped datasets
Remove all
bottle (67) @ TT043

# US JGOFS: one of many programs



# Shifting expectations

1. 1980 Experiment data
2. 1990 Project data
3. 2000 Program data
4. 2010 Global data


Biological and Chemical Oceanography Data Collection - Mozilla Firefox
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Contact Help NSF Acknowledgment
Search
Programs
Predictability
(38) U.S. GEOTRACES
(2392) U.S. GLOBal ocean ECosystems dynamics
(903) U.S. Joint Global Ocean Flux Study
(51) United States Surface Ocean Lower Atmosphere Study
Projects
(317) U.S. JGOFS Antarctic Environment and Southern Ocean Process Study
(284) U.S. JGOFS Arabian Sea
(202) U.S. JGOFS Equatorial Pacific
(55) U.S. JGOFS North Atlantic Bloom Experiment
(45) U.S. JGOFS Synthesis and Modeling
Deployments
(1) NASA P-3B
(4) TT039
(3) TT040
(7) TT041
(1) TT042
(41) TT043
People
Results
Available datasets
Group by: deployment
Dataset Deployment
Deployment: TT043
aerosols_long TT043
aerosols_short TT043
ammonium TT043
areal_sum TT043
bacteria TT043
bottle TT043
cruise_reports TT043
Page 1 of 5
1 - 25 of 41
Mapped datasets
Remove all
bottle (67) @ TT043
Visible deployments
Clear selections
TT043
Map
Zoom in Pan Query map Clear query
Map options
Saudi Arabia
Oman
Yemen
Somalia
Ethiopia
India
Karachi
Kolkata
Mumbai
20°00'N
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40°00'E
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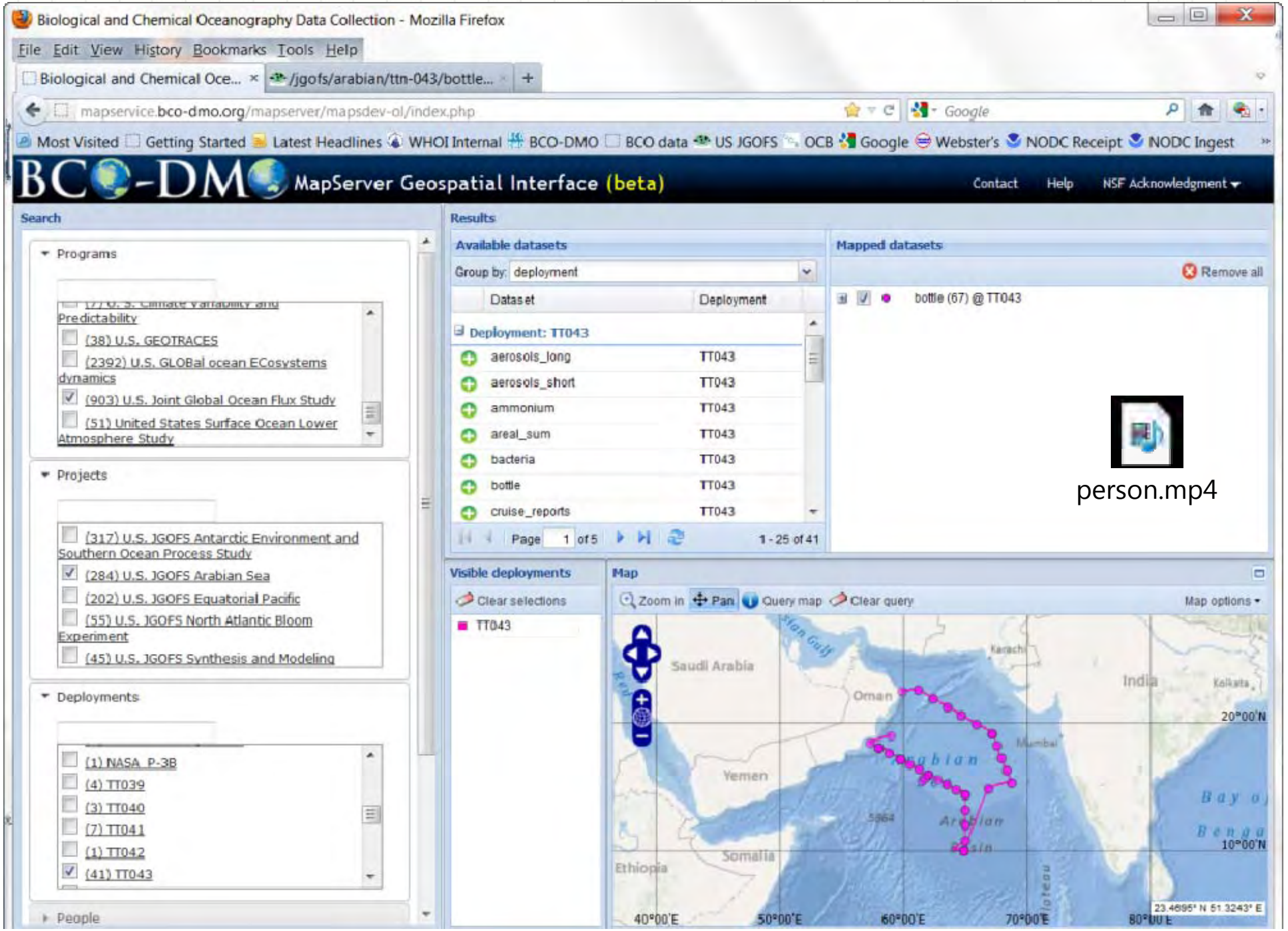
60°00'E
70°00'E
23.4695° N 51.3243° E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ammonium TT043
areal_sum TT043
bacteria TT043
bottle TT043
cruise_reports TT043
Page 1 of 5
1 - 25 of 41
Mapped datasets
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Clear selections
TT043
Map
Zoom in Pan Query map Clear query
Map options
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Oman
India
Yemen
Somalia
Ethiopia
Karachi
Mumbai
Kolkata
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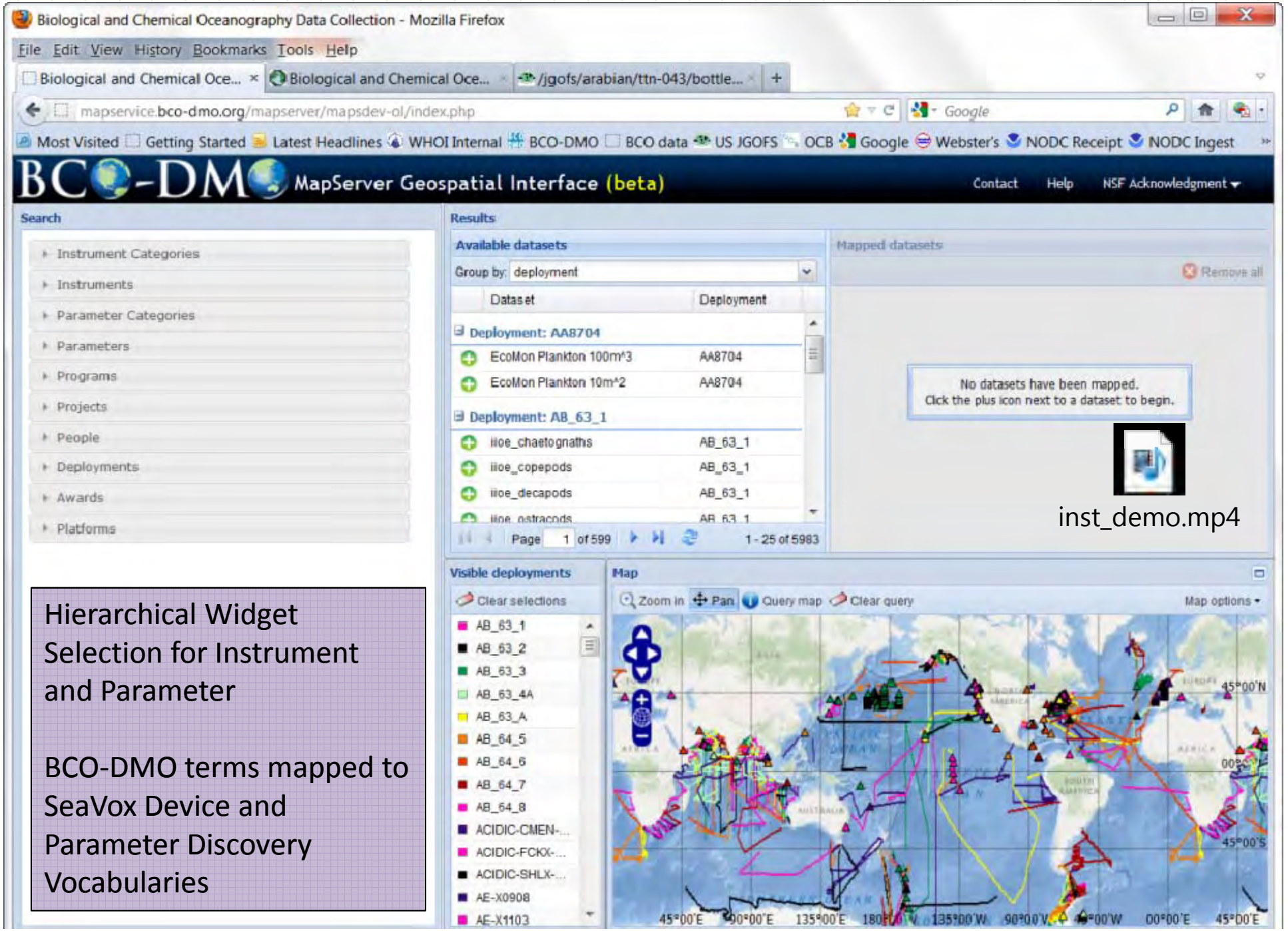



Hierarchical Widget Selection for Instrument and Parameter

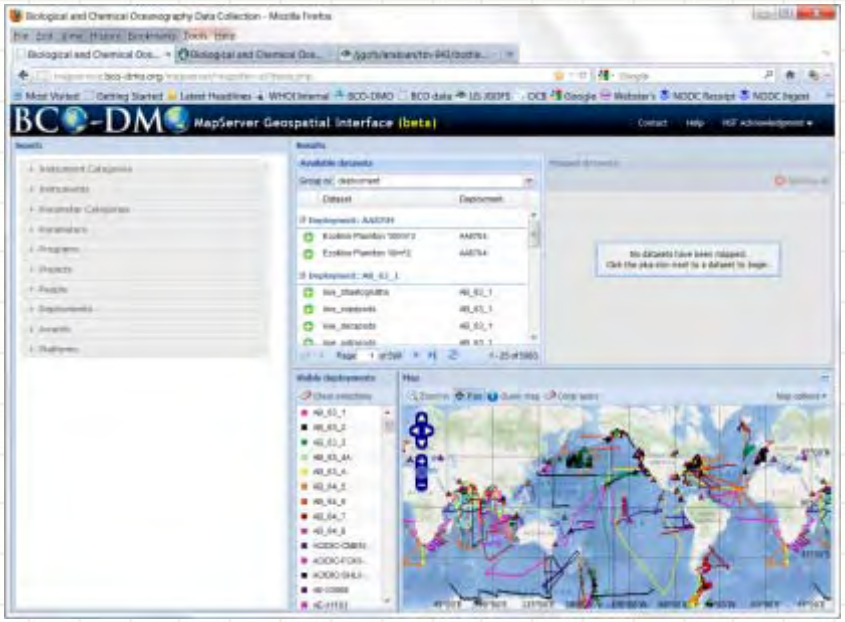
BCO-DMO terms mapped to SeaVox Device and Parameter Discovery Vocabularies

# CREDITS

## BCO-DMO staff:

Dicky Allison

Bob Groman




## RPI-TWC: S2S and Ontology

Eric Rozell

Patrick West

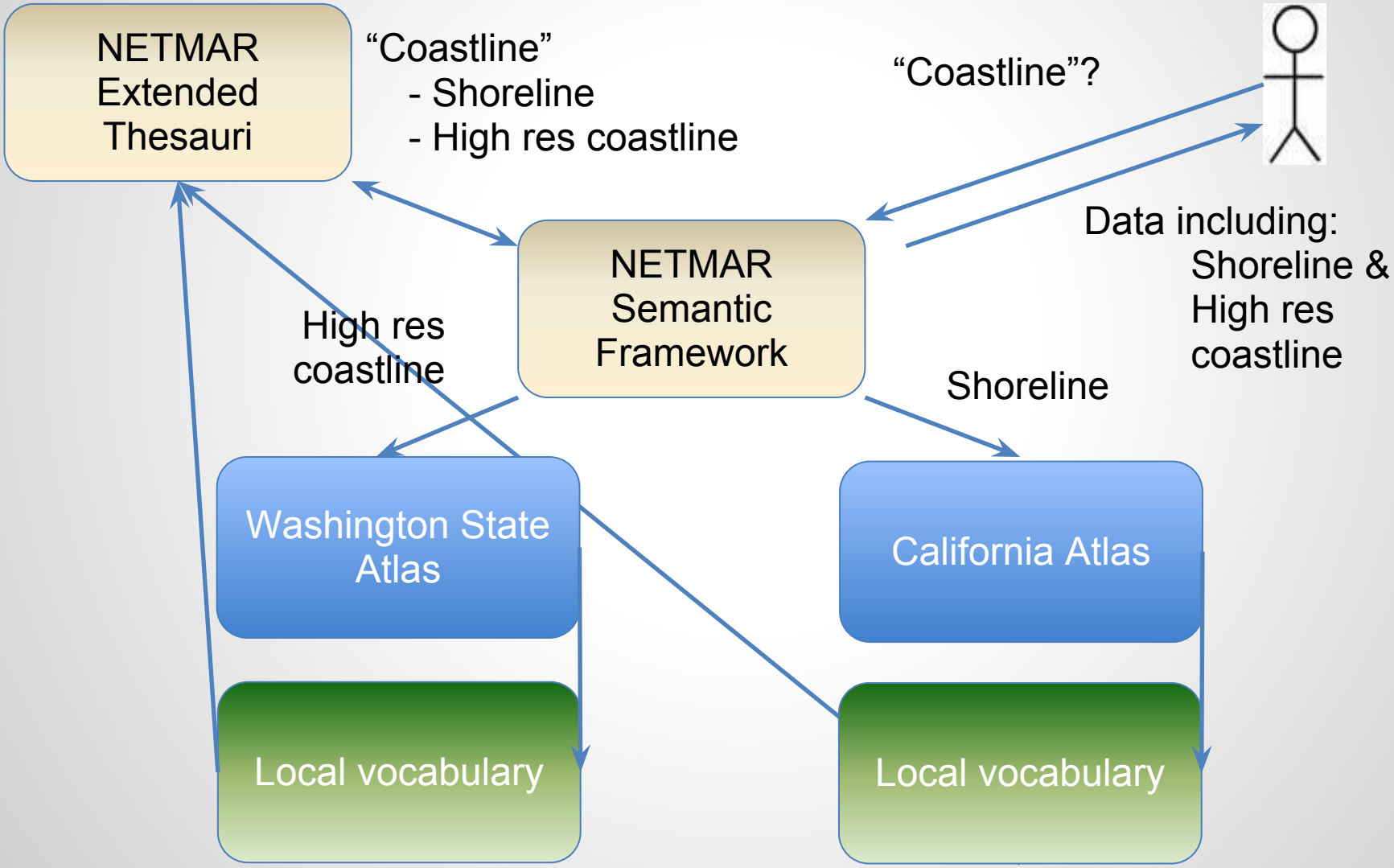
Stefan Zednick

Peter Fox

## Charlton Galvarino (map)

# Vocabularies and facets

# ICAN Use Case



# ICAN Use Case

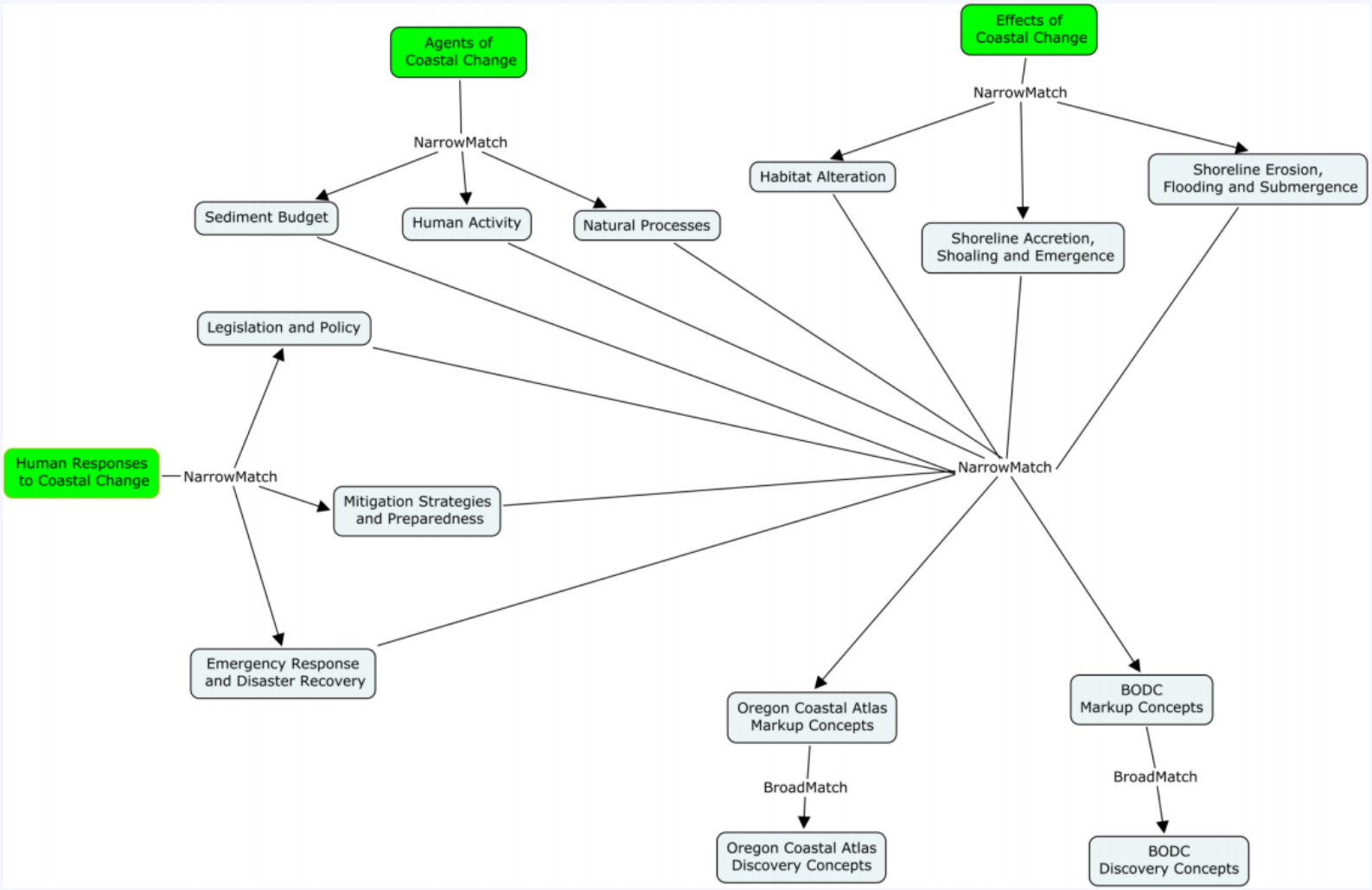



**Figure 1.** ICAN Coastal Erosion Mapping

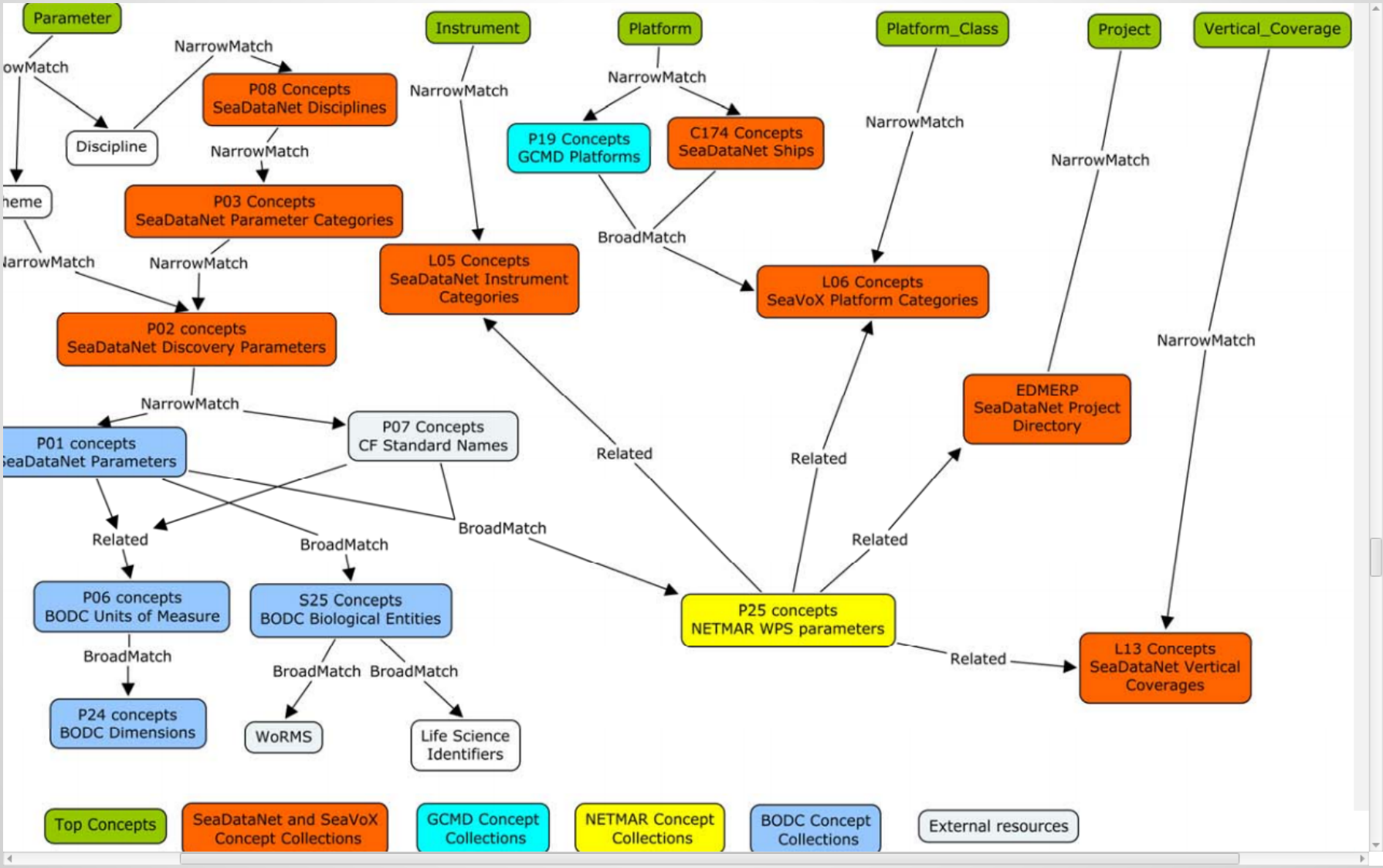
# ICAN Use Case

- Terms registered in a vocabulary server

- Accessed through API

- Semantic Mediator (based on CSW) handles inferencing

# NETMAR Faceted Resource



# Register development

- Latest SKOS specification
- Payload includes governance & provenance information

- Ability to deliver true thesauri as concept schemes

- Provision for multilingual support

# Register development

- RESTful and SOAP interfaces

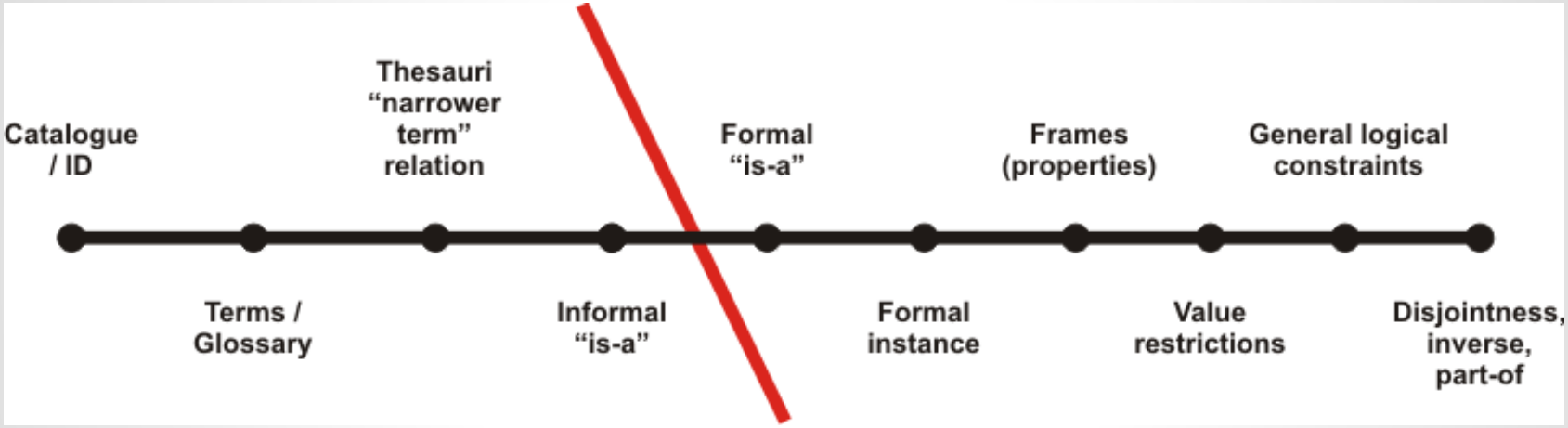
- Nine methods available in API

- Concept deprecation an option

- Visualisation, search and edit tools

- Poster XY421 tomorrow

# Spectrum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Thesauri "narrower term" relation
Formal "is-a"
Frames (properties)
General logical constraints
Terms / Glossary
Informal "is-a"
Formal instance
Value restrictions
Disjointness, inverse, part-of

eumis

Sign In

Welcome | WIKI | Forum | The Pilots | Test

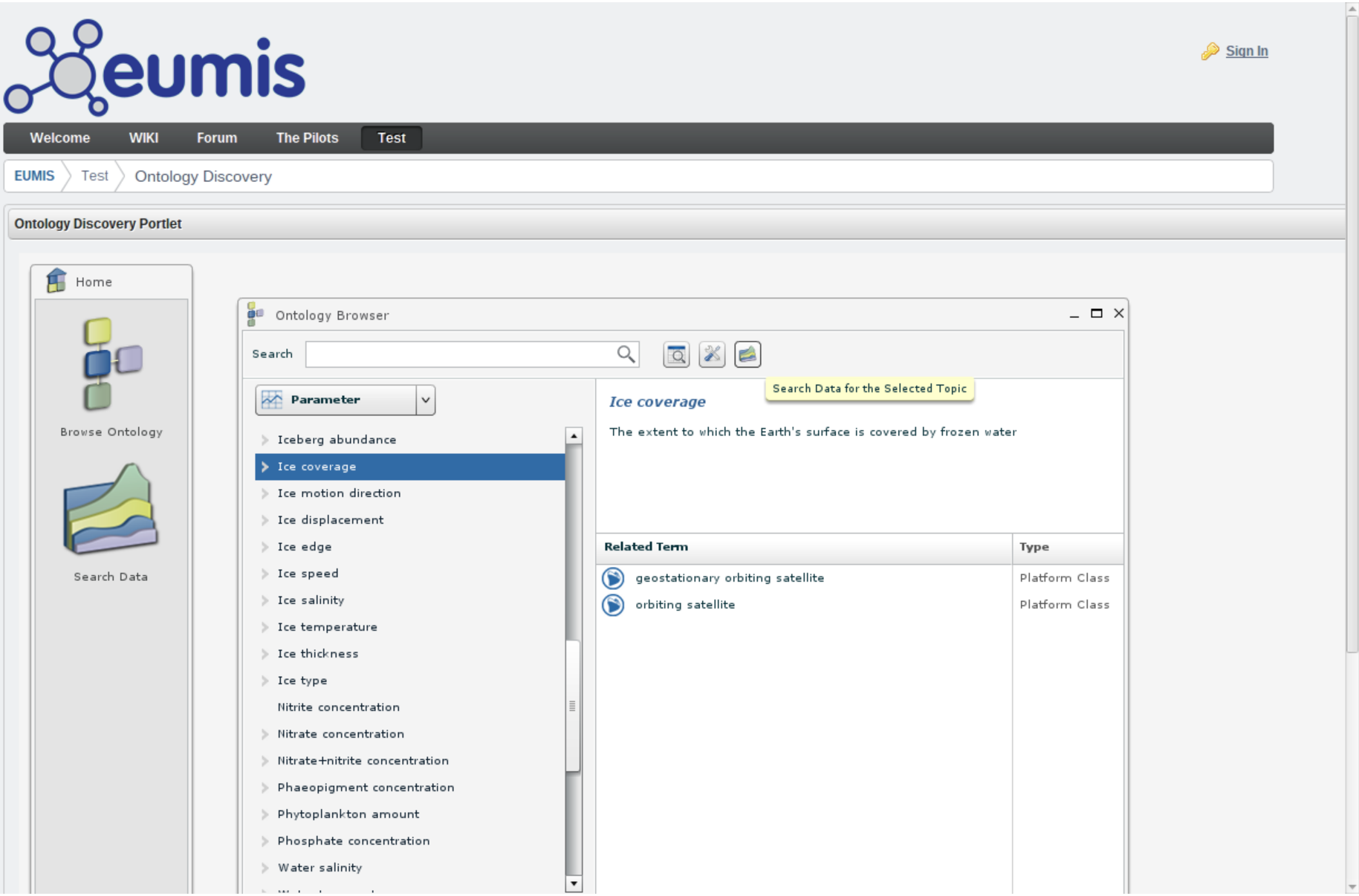
EUMIS > Test > Ontology Discovery

**Ontology Discovery Portlet**

Home

Browse Ontology

Search Data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Forum
The Pilots
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Ontology Browser
Search
Search Data for the Selected Topic
Parameter
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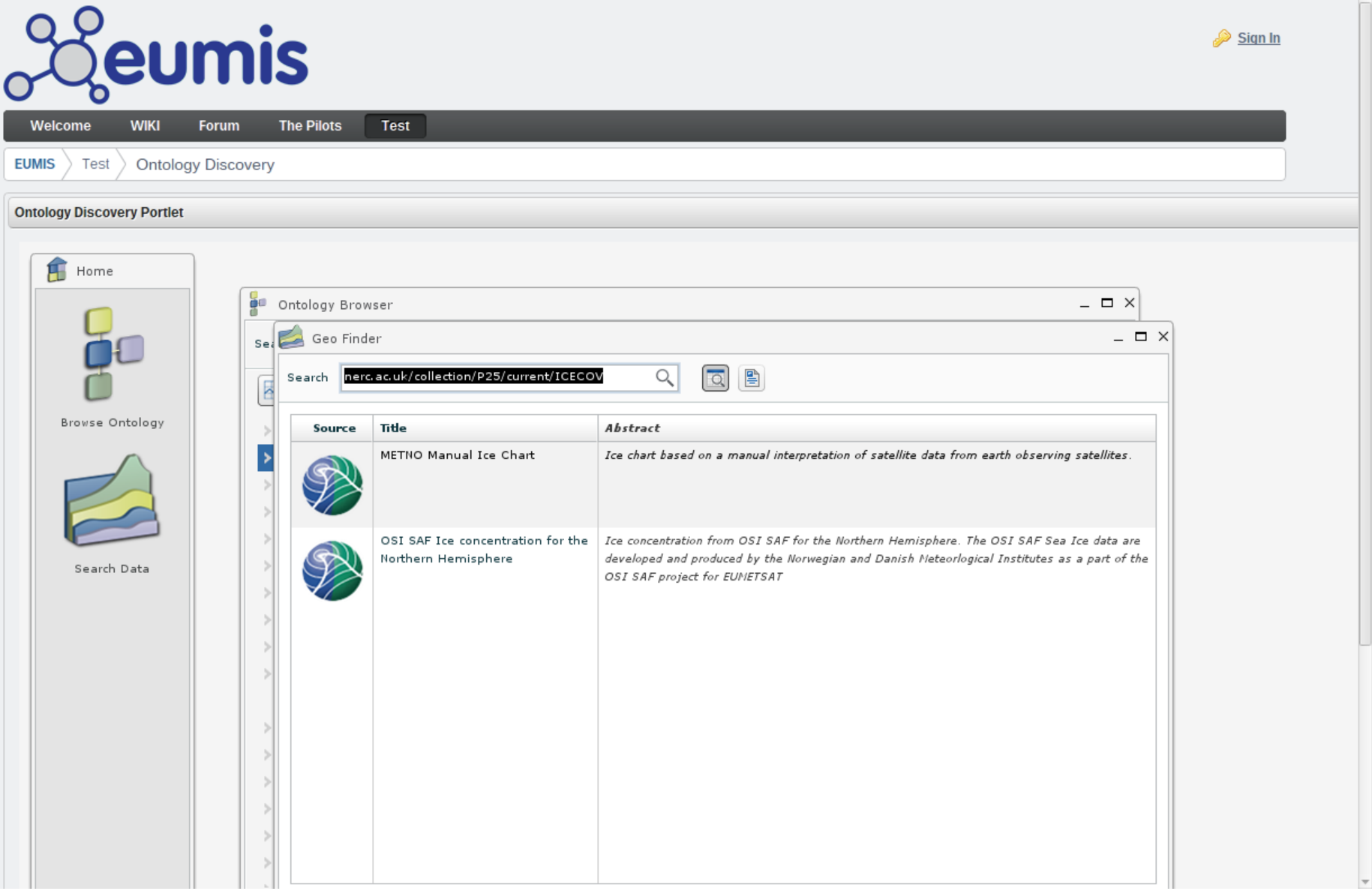
Ice coverage
Ice motion direction
Ice displacement
Ice edge
Ice speed
Ice salinity
Ice temperature
Ice thickness
Ice type
Nitrite concentration
Nitrate concentration
Nitrate+nitrite concentration
Phaeopigment concentration
Phytoplankton amount
Phosphate concentration
Water salinity
Ice coverage
The extent to which the Earth's surface is covered by frozen water
Related Term
Type
geostationary orbiting satellite
Platform Class
orbiting satellite
Platform Class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The Pilots
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EUMIS
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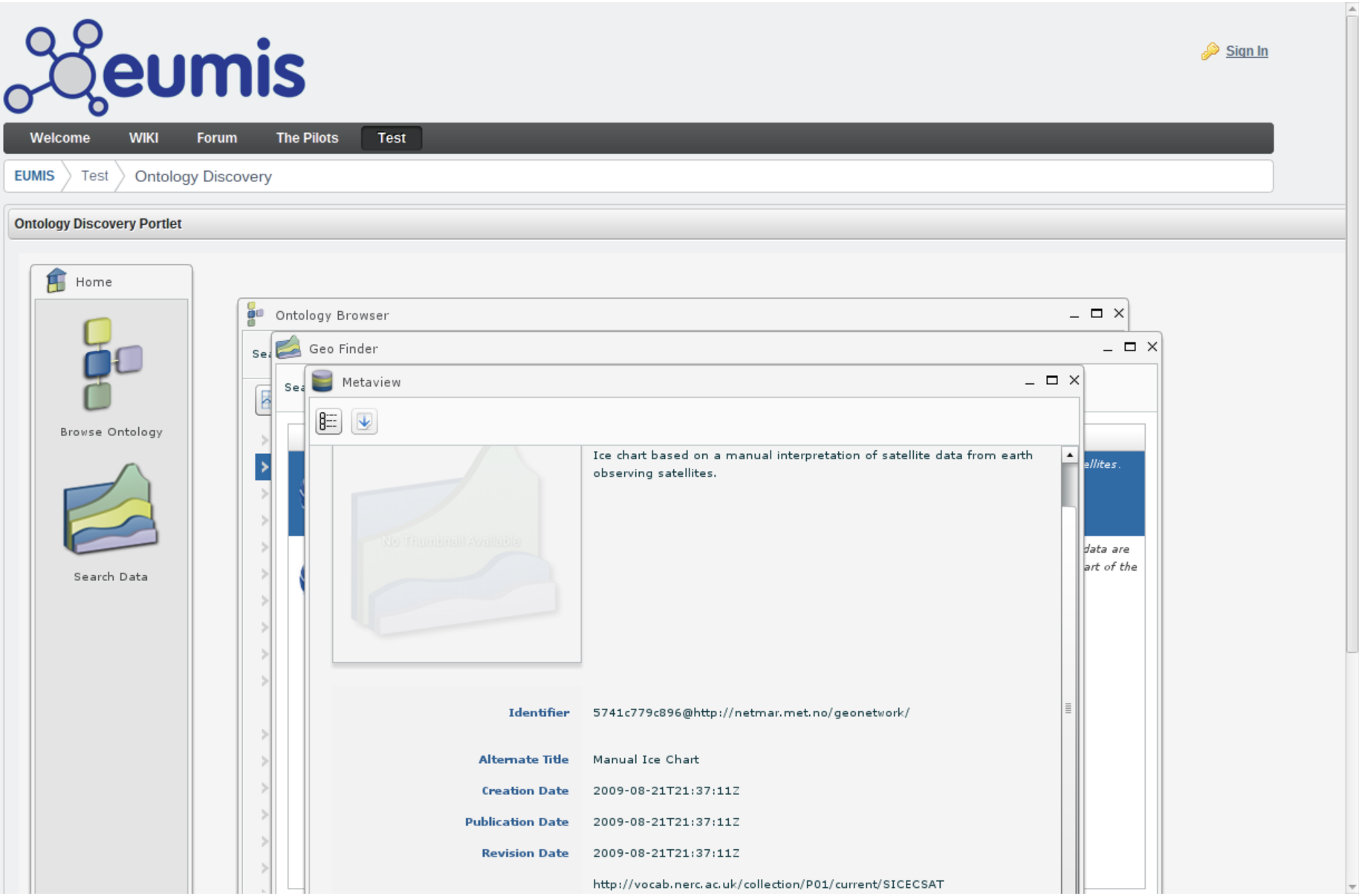
Ontology Discovery
Ontology Discovery Portlet
Home
Browse Ontology
Search Data
Ontology Browser
Geo Finder
Search
nerc.ac.uk/collection/P25/current/ICECOV
Source
Title
Abstract
METNO Manual Ice Chart
Ice chart based on a manual interpretation of satellite data from earth observing satellites.
OSI SAF Ice concentration for the Northern Hemisphere
Ice concentration from OSI SAF for the Northern Hemisphere. The OSI SAF Sea Ice data are developed and produced by the Norwegian and Danish Meteorlogical Institutes as a part of the OSI SAF project for EUMETSAT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PML | Plymouth Marine Laboratory

Marine Matters

SEVENTH FRAMEWORK PROGRAMME

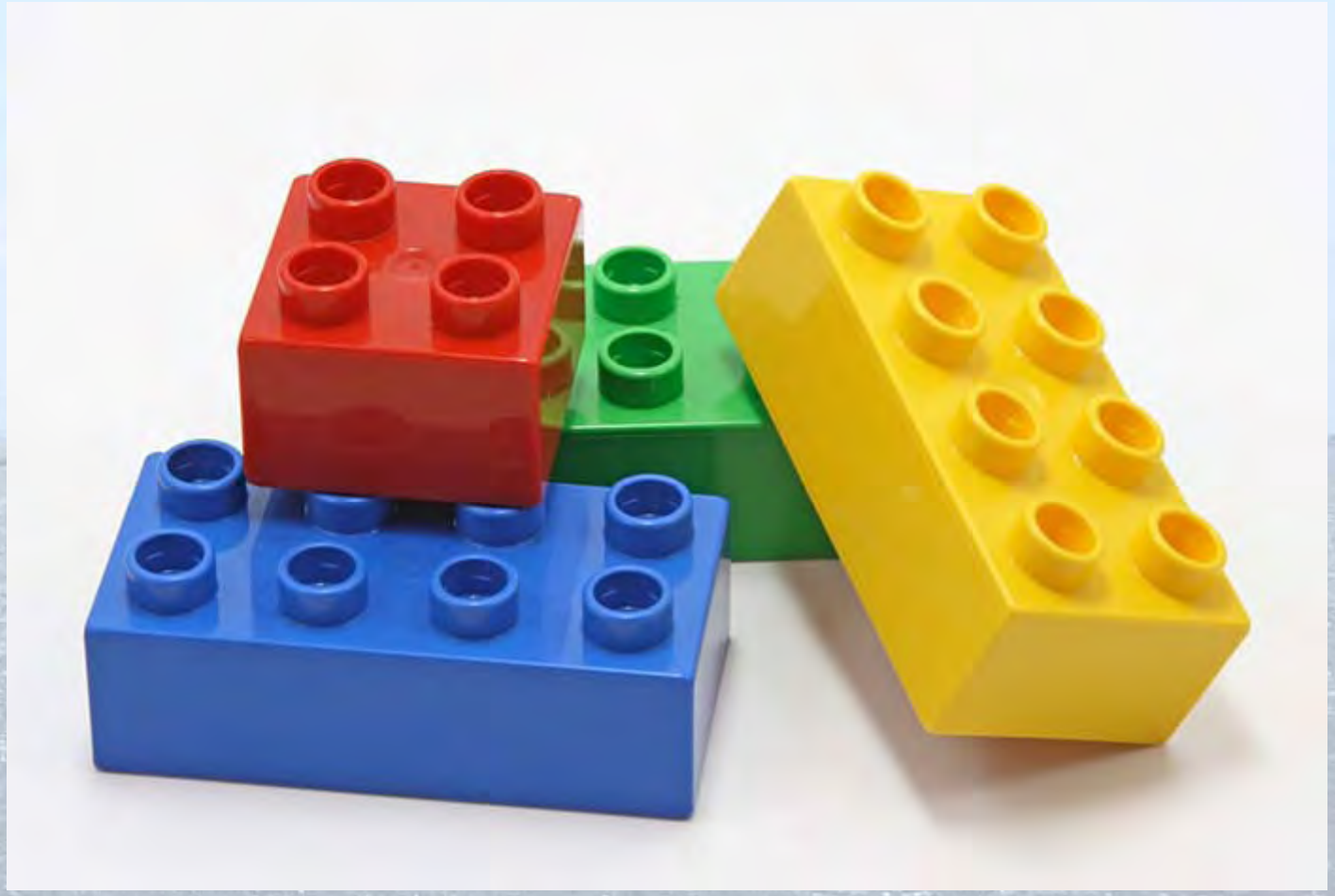
# NETMAR Services

Jorge de Jesus

Peter Walker

Mike Grant

EGU, Vienna,2012



# Service Oriented Architecture – Nice building blocks

EGU, Vienna April 2012

SEVENTH FRAMEWORK PROGRAMME

PML | Plymouth Marine Laboratory **KeyWork**

# Interoperability

**(it can be a problem....)**

EGU, Vienna April 2012

SEVENTH FRAMEWORK PROGRAMME

# PML Plymouth Marine Laboratory — Web Processing Service

http://www.opengeospatial.org/standards/wps

web processing service

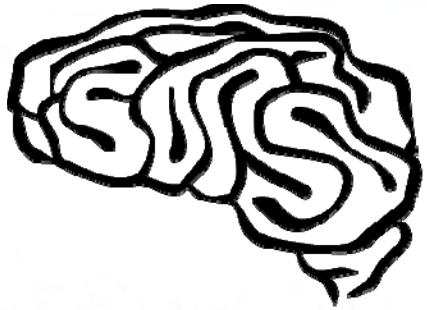
sited | Release Notes | Fedora Project | web.input (web.py) | Red Hat | Free Content | Main Page - PyWPS

Home | Standards | Programs | Participate | OGC Blog | Events | About OGC | Member Login | Search

**Standards**

- **OGC® Standards**
  - Cat: ebRIM App Profile: Earth Observation Products
  - Catalogue Service
  - CityGML
  - Coordinate Transformation
  - Filter Encoding
  - GML in JPEG 2000
  - GeoAPI
  - Geographic Objects
  - Geography Markup Language
  - Geospatial eXtensible Access Control Markup Language (GeoXACML)
  - KML
  - Location Services (OpenLS)
  - NetCDF
  - Observations and Measurements
  - Open GeoSMS
  - Ordering Services Framework for Earth Observation Products
  - PUCK
  - SWE Common Data Model
  - SWE Service Model
  - Sensor Model Language
  - Sensor Observation Service
  - Sensor Planning Service
  - Simple Features
  - Simple Features CORBA
  - Simple Features OLE/COM
  - Simple Features SQL
  - Styled Layer Descriptor
  - Symbology Encoding

## Web Processing Service



### Web Processing Service

1) Overview
2) Downloads
3) Official Schemas
4) Related News

### 1) Overview

The OpenGIS® Web Processing Service (WPS) Interface Standard provides rules for standardizing how inputs and outputs (requests and responses) for geospatial processing services, such as polygon overlay. The standard also defines how a client can request the execution of a process, and how the output from the process is handled. It defines an interface that facilitates the publishing of geospatial processes and clients' discovery of and binding to those processes. The data required by the WPS can be delivered across a network or they can be available at the server.

### 2) Downloads

| Version | Document Title (click to download) | Document # | Type |
|---|---|---|---|
| 1.0.0 | Web Processing Service | 05-007r7 | IS |
| | Corrigendum for OpenGIS Implementation Standard Web Processing Service (WPS) 1.0.0 (0.0.8) | 08-091r6 | ISC |
| | Web Processing Service Best Practices Discussion Paper | 12-029 | DP |
| 0.4 | Web Processing Service | 05-007r4 | D-RFC |
| 0.3.0 | Web Pro | 05-007r2 | D-DP |
| 0.2.1 | Web Processing Service | 05-007 | D-DP |
| 0.9.1 | Discussions, findings, and use of WPS in OWS-4 | 06-182r1 | DP |
| | OWS-7 Web Processing Service Profiling Engineering Report | 10-059r2 | PER |

**Working Donkey !!!**

Submit a Change Request, Requirement, or Comment for this OGC standard.

### 3) Official Schemas

http://schemas.opengis.net/wps



SEVENTH FRAMEWORK PROGRAMME

# PML | Plymouth Marine Laboratory Web Processing Service



**Contact:**

Author: Jorge S.M. de Jesus

Email: jmdj@pml.ac.uk

Provider: Plymouth Marine Laboratory

Group: Remote Sensing Group

Site: http://rsg.pml.ac.uk


**e.g WPS of shortest path example in OpenLayers, using GRASS-GIS's v.net.path**

**http://rsg.pml.ac.uk/wps/example/index.html**

# PML Plymouth Marine Laboratory Orchestration

OGC®
Making location count.

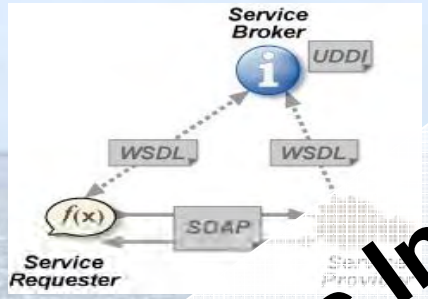
WMS 1.1.1

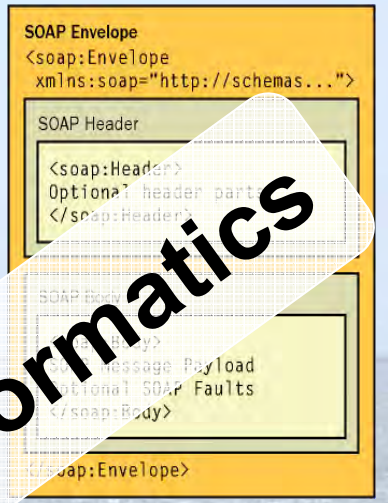
WCS 1.0

<GML>

GeoInformatics

WSDL




Generic Informatics

Apache ODE

# WPS and WSDL

PyWPS

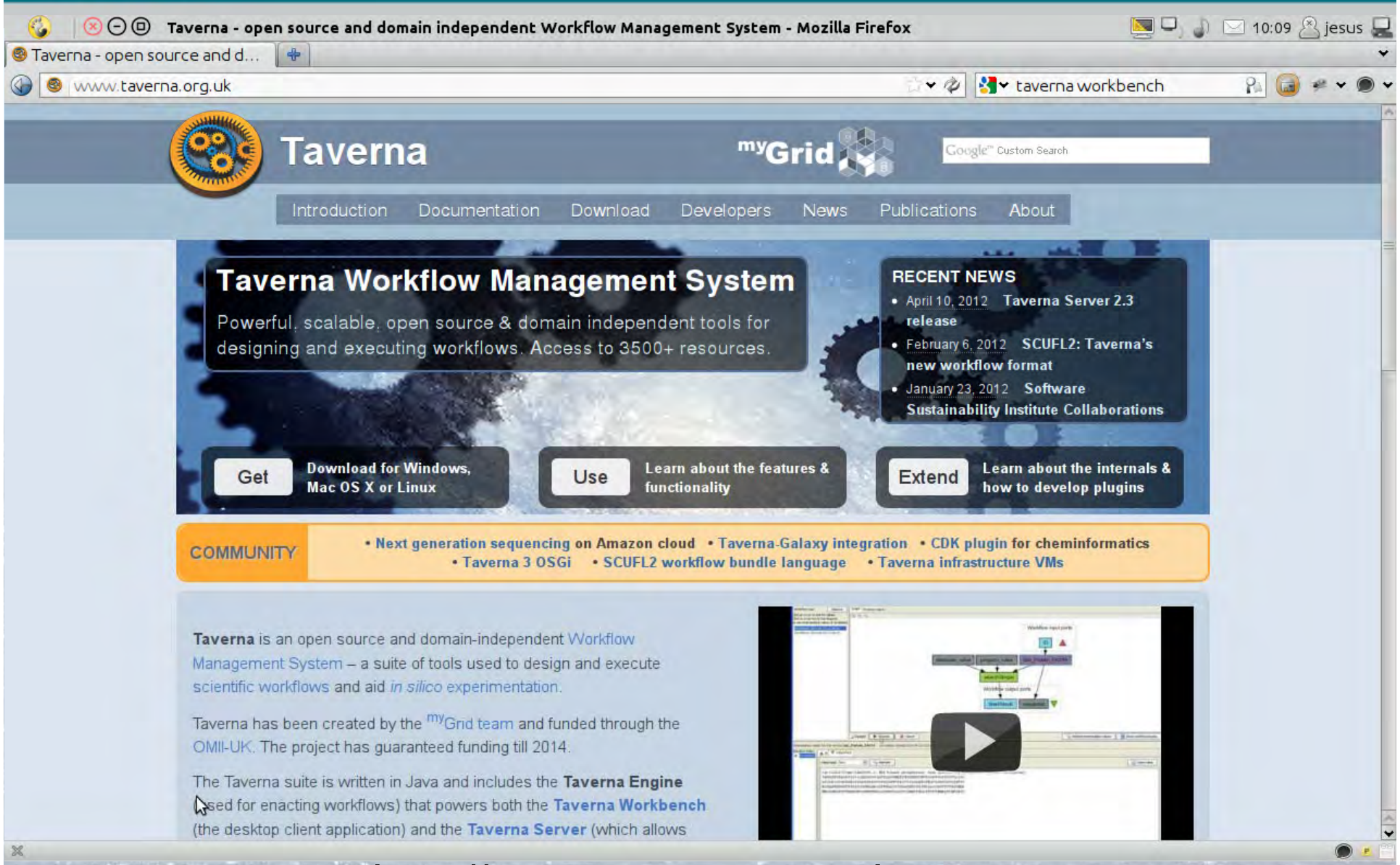

Automatic WPS description (I/O) into WSDL

So what happens now ??? We have a generic service description compatible with lots of systems

Now we can use generic orchestration platforms on WPS !!!!

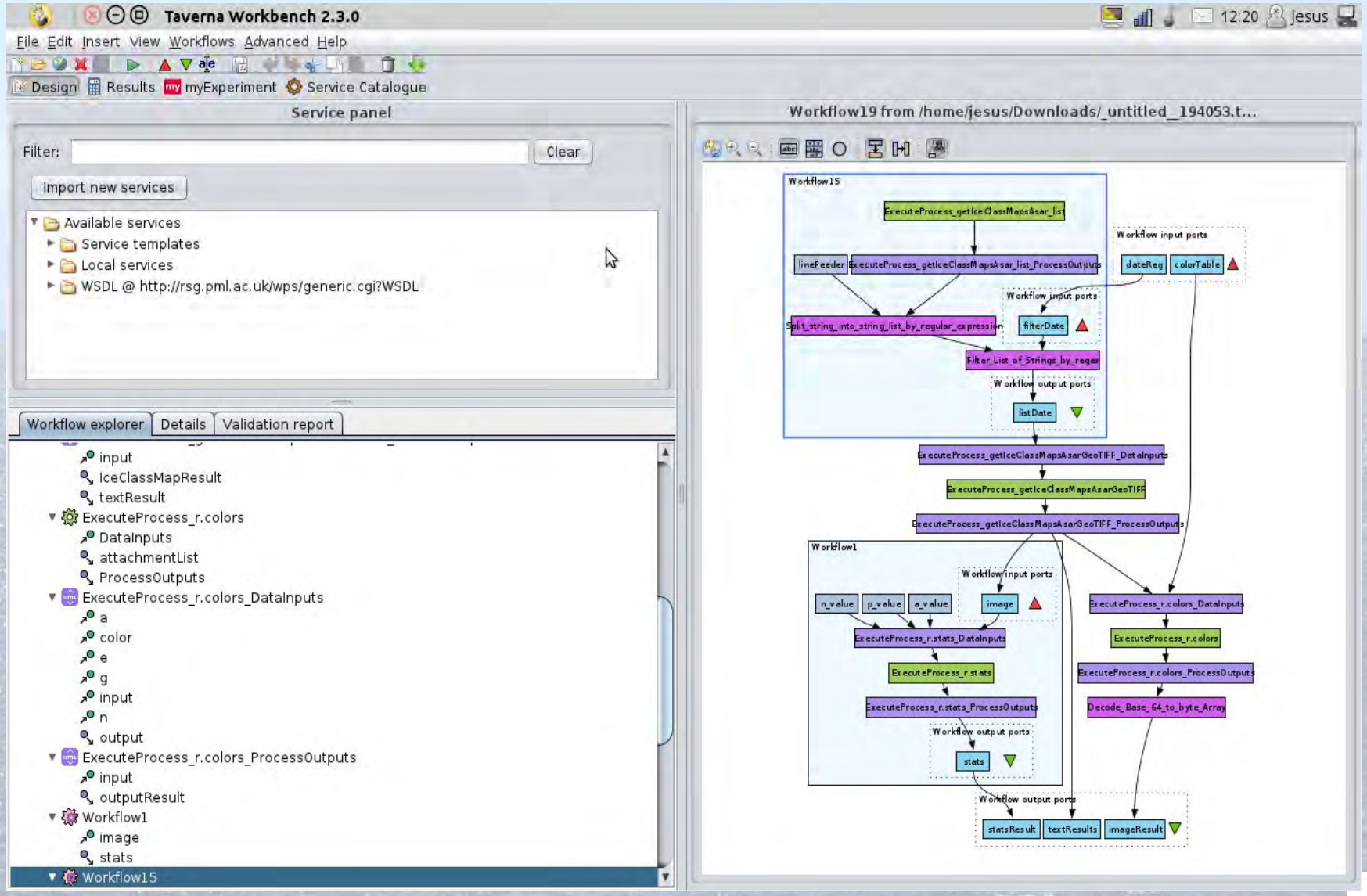
http://pywps.wald.intevation.org/

# WPS and WSDL




http://www.taverna.org.uk

# WPS and WSDL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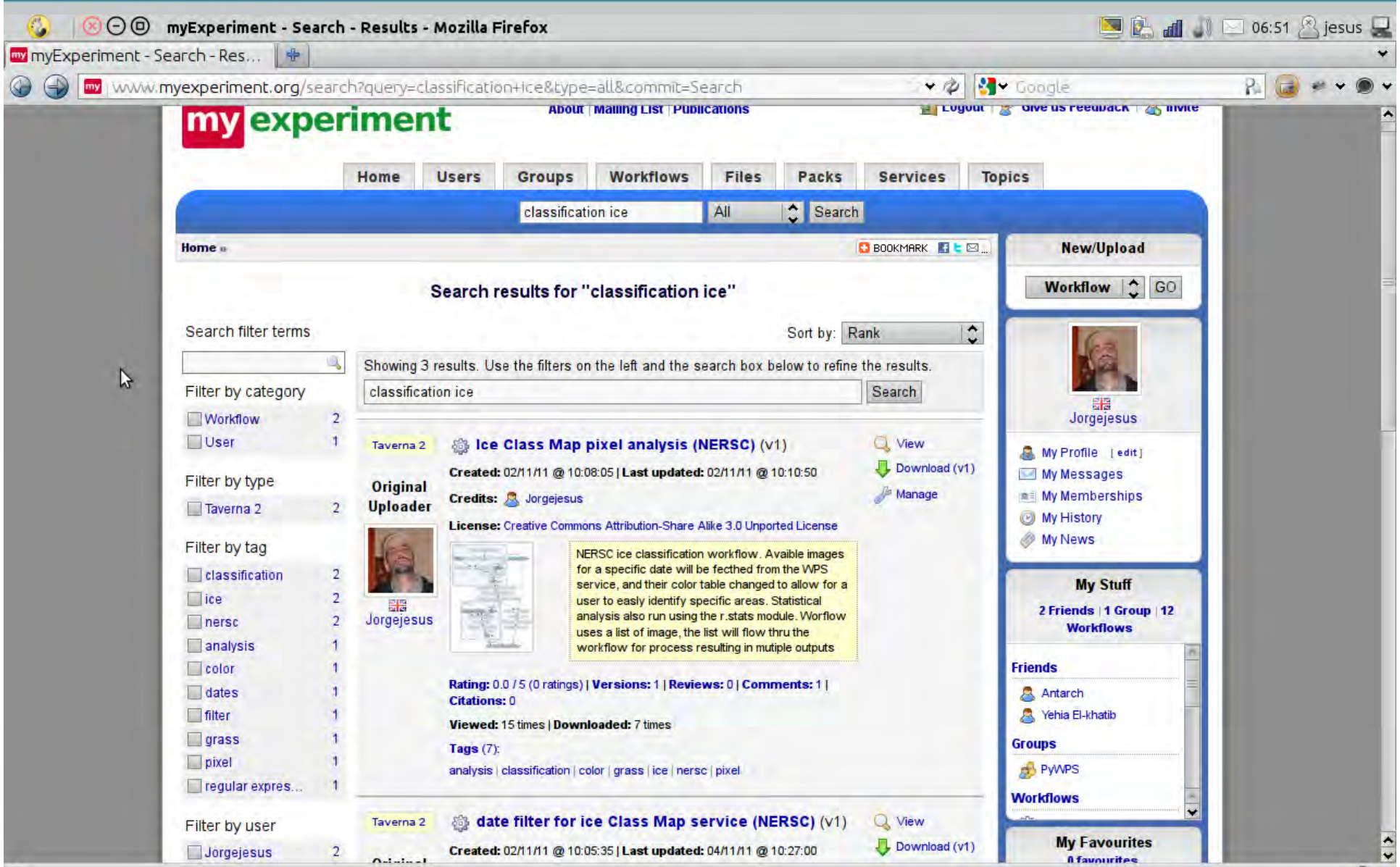
Service panel
Filter:
Clear
Import new services
Available services
Service templates
Local services
WSDL @ http://rsg.pml.ac.uk/wps/generic.cgi?WSDL
Workflow explorer
Details
Validation report
input
IceClassMapResult
textResult
ExecuteProcess_r.colors
DataInputs
attachmentList
ProcessOutputs
ExecuteProcess_r.colors_DataInputs
a
color
e
g
input
n
output
ExecuteProcess_r.colors_ProcessOutputs
input
outputResult
Workflow1
image
stats
Workflow15
Workflow19 from /home/jesus/Downloads/_untitled_194053.t...
Workflow15
ExecuteProcess_getIceClassMapsAsar_list
lineFeeder
ExecuteProcess_getIceClassMapsAsar_list_ProcessOutputs
Workflow input ports
dateReg
colorTable
filterDate
Split_string_into_string_list_by_regular_expression
Filter_List_of_Strings_by_regex
Workflow output ports
listDate
ExecuteProcess_getIceClassMapsAsarGeoTIFF_DataInputs
ExecuteProcess_getIceClassMapsAsarGeoTIFF
ExecuteProcess_getIceClassMapsAsarGeoTIFF_ProcessOutputs
Workflow1
n_value
p_value
a_value
image
ExecuteProcess_r.stats_DataInputs
ExecuteProcess_r.stats
ExecuteProcess_r.stats_ProcessOutputs
stats
ExecuteProcess_r.colors_DataInputs
ExecuteProcess_r.colors
ExecuteProcess_r.colors_ProcessOutputs
Decode_Base_64_to_byte_Array
statsResult
textResults
imageResult

# WPS and WSDL

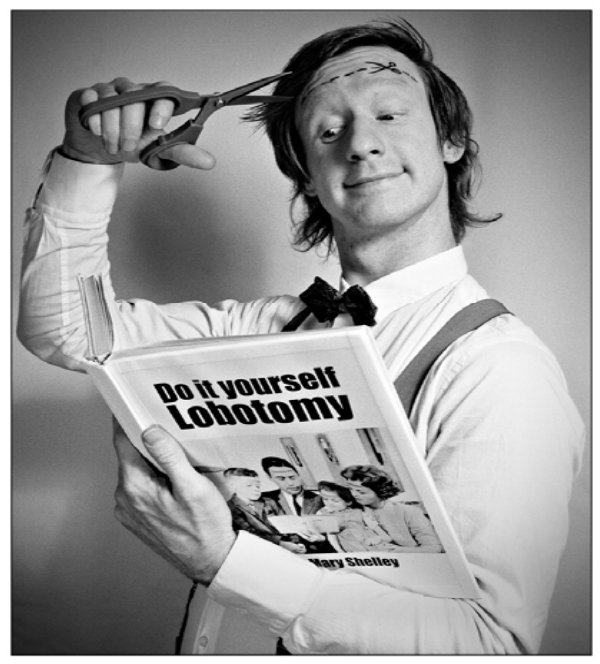



http://www.myexperiment.org/

EGU, Vienna April 2012

# Web and WSDL

**The WPS tool box looks empty, where are the processes ?!!??!**




**DYI**

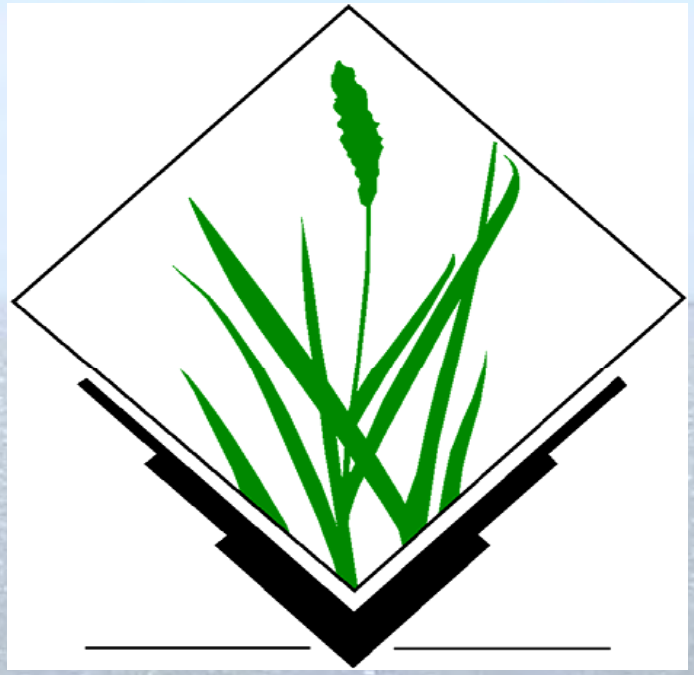
**http://wiki.rsg.pml.ac.uk/pywps/Main_Page**



SEVENTH FRAMEWORK PROGRAMME

# Web and WSDL

**Get GIS and algorithms from other projects !!!**



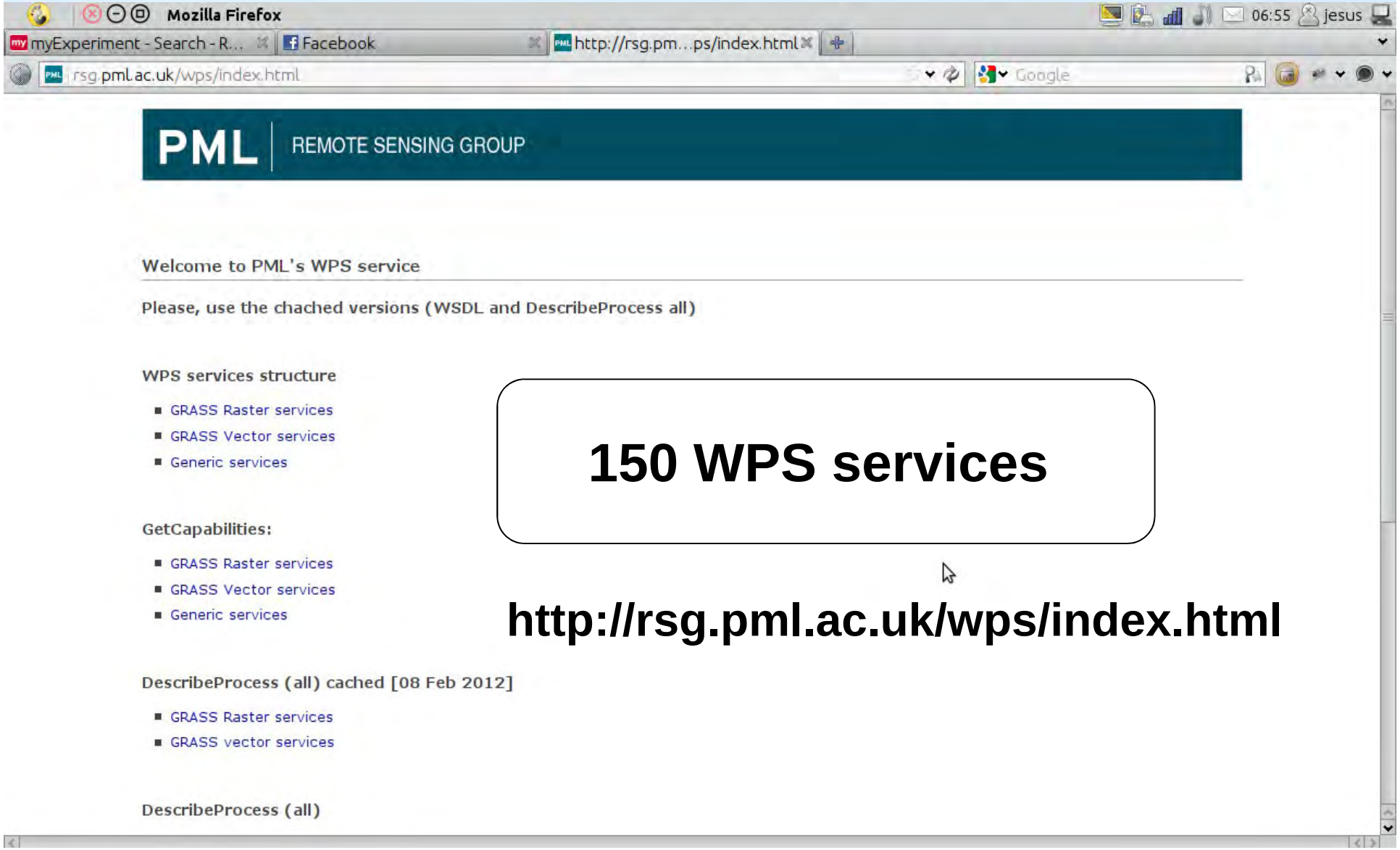
## GRASS GIS

**http://code.google.com/p/wps-grass-bridge/**



SEVENTH FRAMEWORK PROGRAMME

# PML | Plymouth Marine Laboratory WPS and WSDL




**150 WPS services**

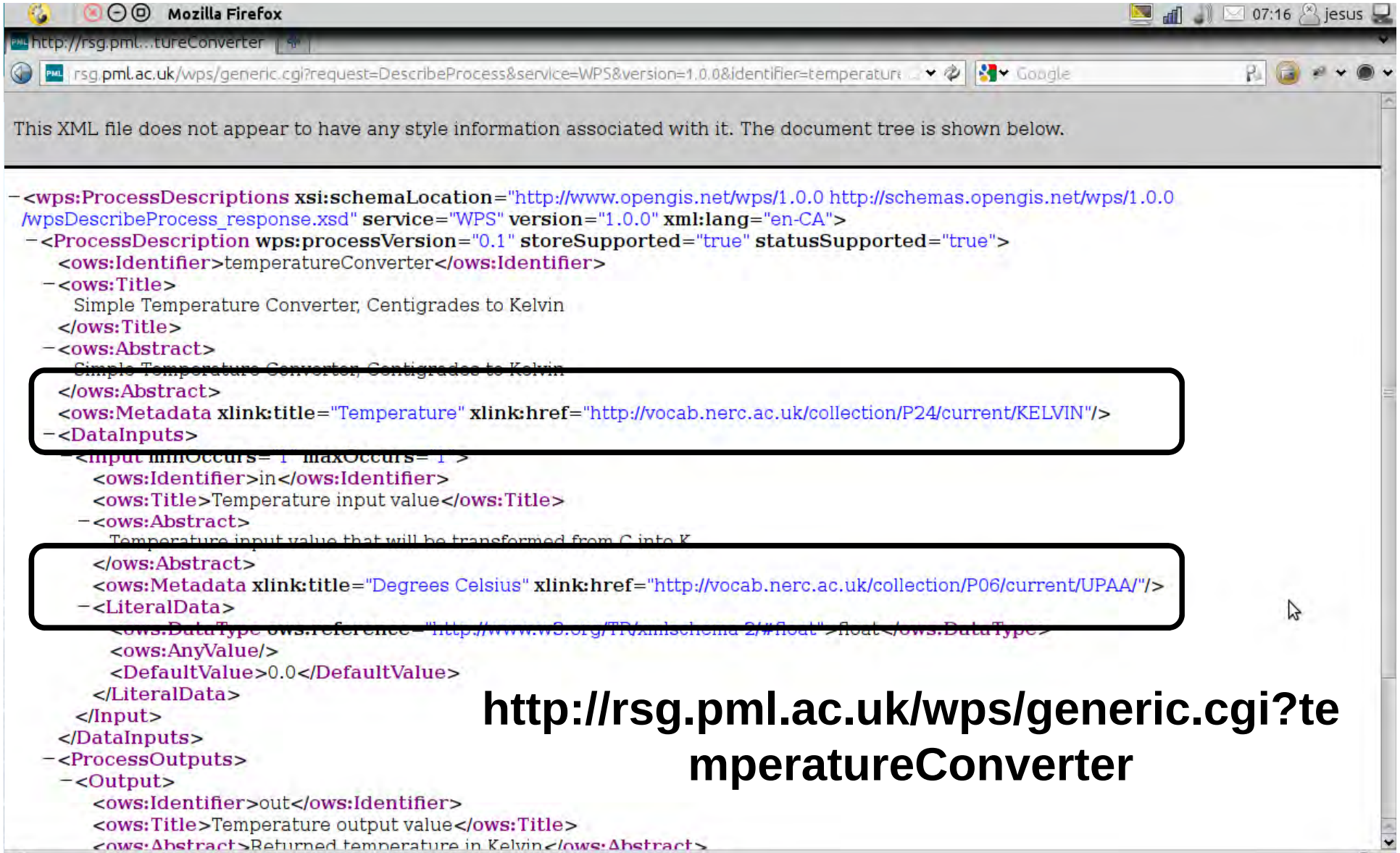
**http://rsg.pml.ac.uk/wps/index.html**

# Semantics

**Ohhh the blocks don' fit!!!  0_O**



SEVENTH FRAMEWORK PROGRAMME


Mozilla Firefox
07:16 jesus
http://rsg.pml...tureConverter
rsg.pml.ac.uk/wps/generic.cgi?request=DescribeProcess&service=WPS&version=1.0.0&identifier=temperatur
Google
This XML file does not appear to have any style information associated with it. The document tree is shown below.
<wps:ProcessDescriptions xsi:schemaLocation="http://www.opengis.net/wps/1.0.0 http://schemas.opengis.net/wps/1.0.0/wpsDescribeProcess_response.xsd" service="WPS" version="1.0.0" xml:lang="en-CA">
<ProcessDescription wps:processVersion="0.1" storeSupported="true" statusSupported="true">
<ows:Identifier>temperatureConverter</ows:Identifier>
<ows:Title>
Simple Temperature Converter, Centigrades to Kelvin
</ows:Title>
<ows:Abstract>
</ows:Abstract>
<ows:Metadata xlink:title="Temperature" xlink:href="http://vocab.nerc.ac.uk/collection/P24/current/KELVIN"/>
<DataInputs>
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<ows:Title>Temperature input value</ows:Title>
<ows:Abstract>
</ows:Abstract>
<ows:Metadata xlink:title="Degrees Celsius" xlink:href="http://vocab.nerc.ac.uk/collection/P06/current/UPAA/"/>
<LiteralData>
<ows:AnyValue/>
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</LiteralData>
</Input>
</DataInputs>
<ProcessOutputs>
<Output>
<ows:Identifier>out</ows:Identifier>
<ows:Title>Temperature output value</ows:Title>
http://rsg.pml.ac.uk/wps/generic.cgi?temperatureConverter
Semantics may help !!!
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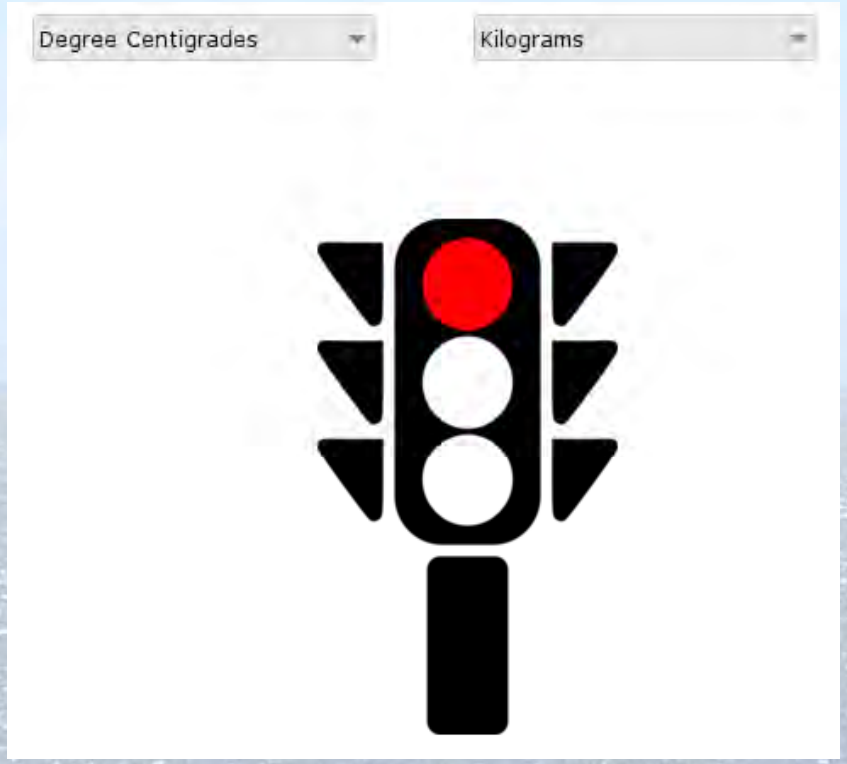
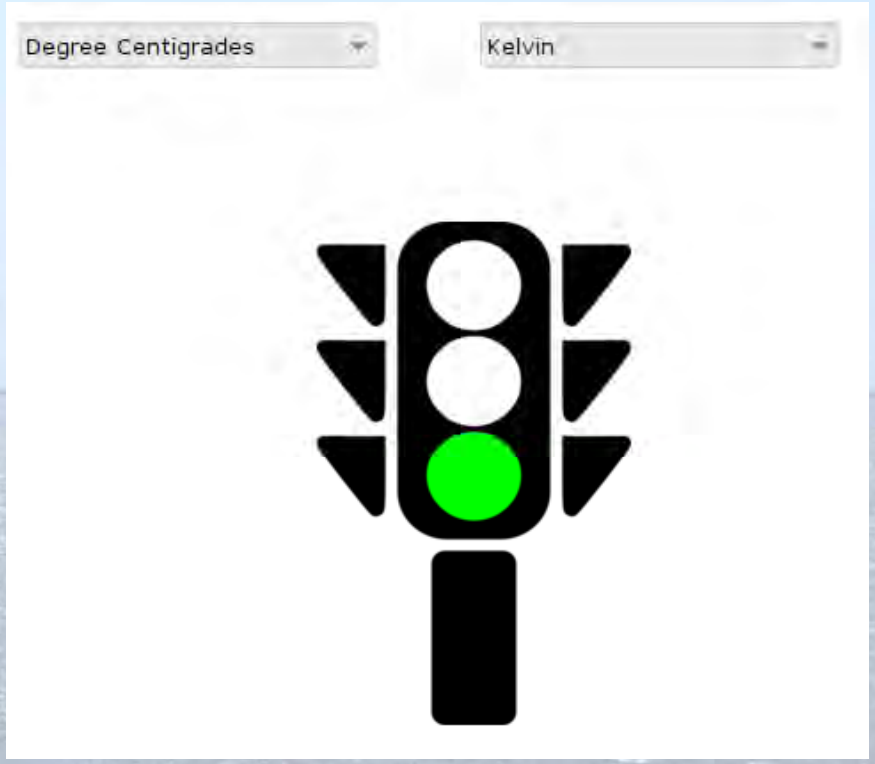
SEVENTH FRAMEWORK PROGRAMME

# Semantics




http://rsg.pml.ac.uk/rest/test.html

http://rsg.pml.ac.uk/rest/index.html

# Questions ?!

Questions ?!



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